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RTN 3-23246

Volume 4: Appendices A through O
**Phase II Comprehensive Site
Assessment, Method 3 Risk
Characterization, and Phase III
Remedial Action Plan**

50 Tufts Street, Somerville, Massachusetts

Submitted to:
UniFirst Corporation
68 Jonspin Road
Wilmington, MA 01887

Prepared by:
GEI Consultants, Inc.
400 Unicorn Park Drive
Woburn, MA 01801
781.721.4000

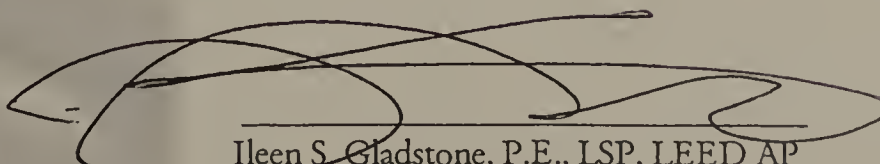
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Ileen S. Gladstone, P.E., LSP, LEED AP
Vice President



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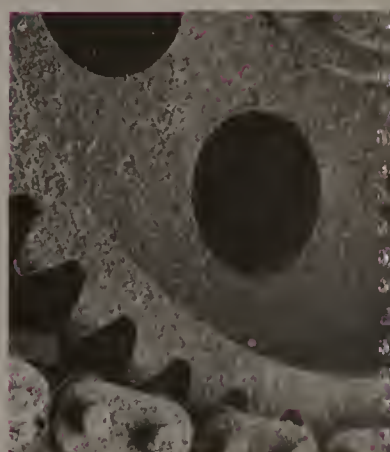
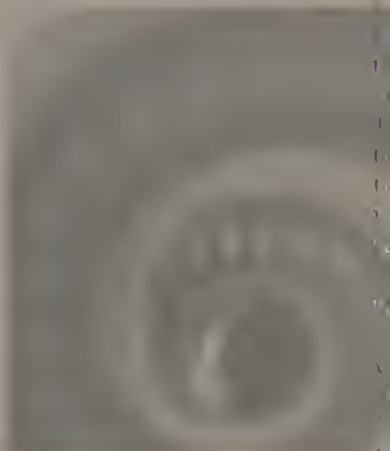


Appendix A

DEP Transmittal Form (BWSC-108) and Notification Letters



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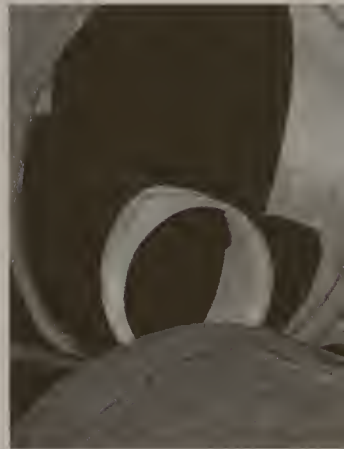


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Plume Stability Assessment

**ASSESSMENT OF SOURCE STABILITY, PLUME STABILITY, AND PLUME
RESPONSE TIME
50 TUFTS STREET SITE
SOMERVILLE, MASSACHUSETTS
RTN # 3-23246**

Prepared for:

UniFirst Corporation
10 Jonspin Road
Wilmington, MA

Prepared by:

Bernard H. Kueper
P.Eng., B.A.Sc., Ph.D.
Kingston, Ontario, Canada

Executive Summary

It is concluded on the basis of statistical testing (Mann-Kendall analysis) that the sources of PCE, TCE and TCA at the 50 Tufts Street Site are stable. The Mann-Kendall analysis indicated that eight of nine source zone monitoring wells exhibited either stable or decreasing PCE concentration trends, nine of nine source zone monitoring wells exhibited either stable or decreasing TCE concentration trends, and nine of nine source zone monitoring wells exhibited either stable or decreasing TCA concentration trends.

It is concluded on the basis of statistical testing (Mann-Kendall analysis) that the PCE, TCE and TCA plumes are stable throughout the available network of monitoring wells. The Mann-Kendall analysis indicated that 28 of 28 plume monitoring wells exhibited either stable or decreasing PCE concentration trends, 27 of 28 plume monitoring wells exhibited either stable or decreasing TCE concentration trends, and 28 of 28 plume monitoring wells exhibited a stable or decreasing TCA concentration trends.

It is concluded on the basis of screening level calculations (plume flushing time, batch flushing model) that plume response times in overburden are expected to be slow (on the order of decades) because of the overall low to moderate hydraulic conductivity, the moderate degree of sorption, and the lack of aggressive biodegradation. Response of the PCE plume to source isolation and/or removal is expected to be slower than that for TCE and TCA because of the initially higher PCE concentrations within the interior of the off-site plume and the higher retardation factor associated with PCE.

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1.0– Introduction

The purpose of this report is to evaluate source stability, plume stability, and plume response time for the 50 Tufts Street site (Site) located in Somerville, Massachusetts. The primary compounds of concern in groundwater include tetrachloroethylene (PCE), trichloroethylene (TCE) and 1,1,1 trichloroethane (TCA). The distribution of these chemicals in groundwater at the Site and in the vicinity of the Site is reflected in groundwater quality data provided by a network of 45 monitoring wells.

The sources of PCE, TCE and TCA are in the form of dense, non-aqueous phase liquids (DNAPLs) present beneath the 50 Tufts Street property and off-site to the east and west (Kueper, 2008a). The DNAPLs are no longer migrating and have reached a stable configuration as a result of capillary trapping forces. The stability of these DNAPL sources is reflected by groundwater concentration data collected from monitoring wells within the area of DNAPL occurrence.

The PCE, TCE and TCA plumes generally extend to the east of the Site, consistent with known groundwater flow directions. Kueper (2008a) divided the groundwater data set into a northern and a southern portion to facilitate an assessment of DNAPL presence. This was warranted given the long, narrow shape of the Site footprint and because it is known that there were a variety of separately located DNAPL handling and storage locations on the Site. There is no need to separate the off-site plume into northern and southern portions for the purposes of assessing plume stability using the employed statistical methodology described further on in this report (the methodology considers each monitoring well independently).

Plume response time relates to the tendency for chemical concentrations to persist once the source to the plume has been either removed or physically isolated from the plume. Plume response time is a function of both chemical properties such as the organic carbon partition coefficient, and hydrogeologic properties such as hydraulic conductivity, hydraulic gradient, fraction organic carbon, distribution of diffusive sinks, and geochemical conditions governing biodegradation. The plume response time is the time required for chemical concentrations to be reduced to target levels following removal or isolation of the source.

2.0– Methodology

2.1 – Source and Plume Stability

Source and plume stability is evaluated here through consideration of groundwater concentration versus time data for all available monitoring wells. Use is made of the Mann-Kendall statistical trend test (at both the 80% and 90% confidence levels) to determine whether PCE, TCE and TCA concentrations are stable (no trend), increasing, or decreasing in each individual monitoring well. The Mann-Kendall test requires that a minimum of four sample events are available; the test cannot be applied using three or fewer data points. If the Mann-Kendall test determines that there is no trend in the data at the 80% confidence level, the coefficient of variation (standard deviation divided by the arithmetic mean) is calculated to assess scatter in the data set. If the

coefficient of variation (CV) is less than one, it can be concluded that the determination of no trend corresponds to stable concentrations. If the coefficient of variation is greater than unity, it is possible that the determination of no trend has been adversely influenced by data variability (fluctuating concentrations). In cases where duplicate sample results were available for a particular sampling date, the higher of the two values was utilized in the analysis.

The Mann-Kendall test is implemented here using an Excel spreadsheet obtained from the State of Wisconsin Department of Natural Resources Remediation and Redevelopment Program (Mann-Kendall Statistical Test Form 4400-215 2/2001). Similar spreadsheets are available from other sources. Use of the Mann-Kendall test to evaluate groundwater concentration trends is discussed further by USEPA (2000).

2.2 – Plume Response Time

Assuming that a plume has been isolated from its source, the persistence of the plume will be governed by a variety of processes including advection (bulk flow of the groundwater), dispersion (a mixing process), desorption (partitioning of chemicals from sorption surfaces on aquifer solids back into the aqueous phase), back-diffusion (diffusion of chemicals from localized low permeability zones back into the more permeable zones), and biodegradation (biologically stimulated degradation of chemicals in groundwater). The relative importance of these processes is site specific in that they depend on both chemical properties (e.g., organic carbon partition coefficients) and hydrogeologic properties (e.g., hydraulic conductivity, presence of low permeability horizons, fraction organic carbon, hydraulic gradient, geochemical conditions facilitating biodegradation).

As discussed by USEPA (1997), there are a variety of ways in which plume response time can be evaluated. The simplest screening level assessment involves calculating the plume response time (t) on the basis of the retardation factor (R) and an estimate of the rate of groundwater flow as follows:

$$t = \frac{L}{v} R \quad (1)$$

where L is the length of the plume and v is the average linear groundwater velocity. Equation (1) corresponds to the length of time required to flush ' R ' pore volumes of water through the aquifer assuming that the only processes of interest are advection and equilibrium desorption. The retardation factor is calculated as:

$$R = 1 + \frac{\rho_b}{\phi} K_{oc} f_{oc} \quad (2)$$

where ρ_b is the dry bulk density of the aquifer material, ϕ is the aquifer porosity, K_{oc} is the chemical specific organic carbon partition coefficient, and f_{oc} is the aquifer fraction organic carbon. The use of (1) to evaluate plume response time at the Site is likely biased towards an under-estimation of the time because (i) dispersion is ignored, and (ii) back-diffusion from low permeability zones is ignored. It can also be noted that while biodegradation would lead to

reduced plume response times, it is a relatively weak process at the Site as evidenced by a general lack of occurrence of daughter products.

An alternative screening level assessment of the plume response time is provided by the batch flushing model (USEPA, 1997):

$$N_{pv} = -R \ln \left(\frac{C}{C_o} \right) \quad (3)$$

where N_{pv} is the number of pore volumes of groundwater that need to be flushed to achieve a target concentration of C given an initial concentration of C_o . The time taken to flush N_{pv} pore volumes of groundwater is estimated as:

$$t = N_{pv} \left(\frac{L}{v} \right) \quad (4)$$

where L and v are as defined in (1). An estimate of v for use in (1) and (4) is given by (Freeze and Cherry, 1979):

$$v = -\frac{K \nabla h}{\phi} \quad (5)$$

where K is the hydraulic conductivity and ∇h is the hydraulic gradient.

3.0– Results

3.1 – Source Stability

Source stability is evaluated using groundwater concentration data from the monitoring wells listed in Table 1. The monitoring wells listed in Table 1 are situated throughout the zone of DNAPL (the source) discussed in Kueper (2008a) and are therefore appropriate for assessing source stability. All groundwater quality data available through April 2008 are utilized in this analysis. Appendix A presents PCE, TCE and TCA concentration versus time plots for each of the monitoring wells listed in Table 1 for which more than one sample event is available.

Table 1 – Monitoring Wells Reflective of Source Concentrations

Monitoring Well	Comments
SH-MW1	Sufficient samples for statistical analysis
SH-MW2	Sufficient samples for statistical analysis
SH-MW3	Sufficient samples for statistical analysis
MW-1	Sufficient samples for statistical analysis
MW-3	Sufficient samples for statistical analysis
GEO-1	Sufficient samples for statistical analysis
GEO-2	Sufficient samples for statistical analysis

GEO-4	Sufficient samples for statistical analysis
GEO-5	Sufficient samples for statistical analysis
SH-1	One sample event for each compound
SH-3	One sample event for each compound
SH-4	One sample event for each compound

PCE

Table 2 summarizes the results of applying the Mann-Kendall test to the PCE concentration data available for the monitoring wells listed in Table 1 that have four or more sample events. Of the nine wells listed in Table 2, eight exhibit either stable (no trend) or decreasing PCE concentration trends at greater than 90% confidence, consistent with source stability. One of the nine wells, SH-MW1, exhibits increasing PCE concentration trends. SH-MW1 was located in the southern portion of the Site outside of the building footprint, but was decommissioned in August 2007.

Table 2 shows that the statistical tests for GEO-2 and MW-3 returned a coefficient of variation greater than unity, indicating that the no trend result may have been influenced by data variability. Visual inspection of the concentration versus time plot for GEO-2 (Appendix A) indicates that all three compounds of interest (PCE, TCE and TCA) exhibited a concentration spike on 1/17/2007 followed by approximately one order of magnitude lower concentrations on 4/12/2007. It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion. Visual inspection of the concentration versus time plot for MW-3 (Appendix A) indicates that all three compounds of interest (PCE, TCE and TCA) exhibited a steep concentration decrease in April 2008, contributing to data variability.

Table 2 – Summary of Mann-Kendall (MK) test results for source zone PCE concentrations

Well	MK Trend > 80% conf	MK Trend > 90% conf	CV if no trend at 80%
SH-MW1	increasing	increasing	n/a
SH-MW2	no trend	no trend	< 1
SH-MW3	no trend	no trend	< 1
MW-1	no trend	no trend	< 1
MW-3	no trend	no trend	> 1
GEO-1	no trend	no trend	< 1
GEO-2	no trend	no trend	> 1
GEO-4	no trend	no trend	< 1
GEO-5	decreasing	decreasing	n/a

As reflected in Table 1, only one PCE sample event is available for monitoring wells SH-1, SH-3 and SH-4, precluding the use of a statistical trend test. The measured PCE concentrations for the groundwater samples obtained from SH-1 (49,700 ppb on 08/09/2004), SH-3 (19,500 ppb on

08/09/2004), and SH-4 (7,240 ppb on 05/25/2006) are consistent with the presence of DNAPL and are on the same order of magnitude as PCE concentrations measured in other source zone monitoring wells.

TCE

Table 3 summarizes the results of applying the Mann-Kendall test to the TCE concentration data available for the monitoring wells listed in Table 1 that have four or more sample rounds. Of the nine wells listed in Table 3, all exhibit either stable (no trend) or decreasing TCE concentration trends, consistent with source stability. Table 3 shows that the statistical test for GEO-1 returned a coefficient of variation greater than unity, indicating that the no trend result may have been influenced by data variability. Visual inspection of the concentration versus time plot for GEO-1 (Appendix A) indicates that all three compounds of interest exhibited a steep decline in concentration for the April 2008 monitoring event, contributing to data variability (but consistent with a decreasing trend in concentration). It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion.

Table 3 shows that the statistical test for GEO-2 returned a coefficient of variation greater than unity, indicating that the no trend result may have been influenced by data variability. Visual inspection of the concentration versus time plot for GEO-2 (Appendix A) indicates that all three compounds of interest (PCE, TCE and TCA) exhibited a concentration spike on 1/17/2007 followed by approximately one order of magnitude lower concentrations on 4/12/2007. It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion.

Table 3 – Summary of Mann-Kendall (MK) test results for source zone TCE concentrations

Well	MK Trend > 80% conf	MK Trend > 90% conf	CV if no trend at 80%
SH-MW1	no trend	no trend	< 1
SH-MW2	no trend	no trend	< 1
SH-MW3	no trend	no trend	< 1
MW-1	decreasing	decreasing	n/a
MW-3	decreasing	no trend	n/a
GEO-1	no trend	no trend	> 1
GEO-2	no trend	no trend	> 1
GEO-4	decreasing	no trend	n/a
GEO-5	decreasing	no trend	n/a

TCA

Table 4 summarizes the results of applying the Mann-Kendall test to the TCA concentration data available for the monitoring wells listed in Table 1 that have four or more sample rounds. Of the nine wells listed in Table 4, all exhibit either stable (no trend) or decreasing TCA concentration trends at greater than 90% confidence, consistent with source stability.

Table 4 indicates that the statistical test for GEO-1 returned a coefficient of variation greater than unity, indicating that the no trend result may have been influenced by data variability. Visual inspection of the concentration versus time plot for GEO-1 (Appendix A) indicates that all three compounds of interest exhibited a steep decline in concentration for the April 2008 monitoring event, contributing to data variability (but consistent with a decreasing trend in concentration). It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion.

Table 4 – Summary of Mann-Kendall (MK) test results for source zone TCA concentrations

Well	MK Trend > 80% conf	MK Trend > 90% conf	CV if no trend at 80%
SH-MW1	decreasing	no trend	n/a
SH-MW2	decreasing	no trend	n/a
SH-MW3	decreasing	decreasing	n/a
MW-1	no trend	no trend	< 1
MW-3	decreasing	no trend	n/a
GEO-1	no trend	no trend	> 1
GEO-2	no trend	no trend	< 1
GEO-4	decreasing	decreasing	n/a
GEO-5	decreasing	no trend	n/a

3.2 – Plume Stability

Plume stability is evaluated using groundwater concentration data from the monitoring wells listed in Table 5. The monitoring wells listed in Table 5 are situated throughout the study area outside of the source zone. All groundwater quality data available through April 2008 are utilized in this analysis. Appendix B presents PCE, TCE and TCA concentration versus time plots for each of the monitoring wells listed in Table 5 for which more than one sample event is available.

Table 5 – Monitoring Wells Reflective of Plume Concentrations

Monitoring Well	Comments
GEO-3	Sufficient samples for statistical analysis
GEO-6	Sufficient samples for statistical analysis
MW-101	Sufficient samples for statistical analysis
MW-102	Sufficient samples for statistical analysis
MW-103	Sufficient samples for statistical analysis
MW-104	Sufficient samples for statistical analysis
MW-105	Sufficient samples for statistical analysis
MW-106	Sufficient samples for statistical analysis
MW-107	Sufficient samples for statistical analysis
MW-108	Sufficient samples for statistical analysis
MW-109	Three sample events

MW-110	Two sample events
MW-111	Sufficient samples for statistical analysis
MW-112A	Sufficient samples for statistical analysis
MW-113	Sufficient samples for statistical analysis
MW-114	Sufficient samples for statistical analysis
MW-115R	Sufficient samples for statistical analysis
MW-116	Sufficient samples for statistical analysis
MW-117S	Sufficient samples for statistical analysis
MW-117T	Sufficient samples for statistical analysis
MW-117D	Sufficient samples for statistical analysis
MW-118S	Sufficient samples for statistical analysis
MW-118T	Sufficient samples for statistical analysis
MW-118D	Sufficient samples for statistical analysis
MW-119S	Sufficient samples for statistical analysis
MW-119T	Sufficient samples for statistical analysis
MW-120S	Sufficient samples for statistical analysis
MW-120D	Sufficient samples for statistical analysis
MW-121S	Three sample events
MW-121D	Three sample events
MW-201	Sufficient samples for statistical analysis
MW-202	Sufficient samples for statistical analysis
MW-203	Two sample events

PCE

Table 6 summarizes the results of applying the Mann-Kendall test to the PCE concentration data available for the monitoring wells listed in Table 5 that have four or more sample events. Of the 28 wells listed in Table 6, all exhibit either stable (no trend) or decreasing PCE concentration trends at greater than 90% confidence, consistent with plume stability.

Table 6 – Summary of Mann-Kendall (MK) test results for plume PCE concentrations

Well	MK Trend > 80% conf	MK Trend > 90% conf	CV if no trend at 80%
GEO-3	decreasing	no trend	n/a
GEO-6	decreasing	no trend	n/a
MW-101	no trend	no trend	< 1
MW-102	no trend	no trend	< 1
MW-103	no trend	no trend	< 1
MW-104	decreasing	decreasing	n/a
MW-105	no trend	no trend	> 1
MW-106	no trend	no trend	< 1
MW-107	no trend	no trend	< 1
MW-108	no trend	no trend	< 1
MW-111	decreasing	decreasing	n/a
MW-112A	no trend	no trend	< 1
MW-113	no trend	no trend	< 1
MW-114	no trend	no trend	< 1

MW-115R	no trend	no trend	< 1
MW-116	no trend	no trend	> 1
MW-117S	no trend	no trend	< 1
MW-117T	no trend	no trend	< 1
MW-117D	no trend	no trend	< 1
MW-118S	no trend	no trend	< 1
MW-118T	no trend	no trend	< 1
MW-118D	decreasing	no trend	n/a
MW-119S	no trend	no trend	< 1
MW-119T	no trend	no trend	< 1
MW-120S	no trend	no trend	< 1
MW-120D	increasing	no trend	n/a
MW-201	no trend	no trend	< 1
MW-202	increasing	no trend	n/a

Table 6 shows that the coefficient of variation for MW-105 exceeds unity, indicating that the no trend result may be influenced by data variability. Inspection of the PCE concentration versus time plot for MW-105 in Appendix B shows that the high coefficient of variation is attributable to the very first data point which is approximately one order of magnitude higher than the seven subsequent results which are all below target levels. Given that the well was sampled seven times following the initial result, it is reasonable to conclude that concentrations are stable.

Table 6 shows that the coefficient of variation for MW-116 exceeds unity, indicating that the no trend result may be influenced by data variability. Inspection of the PCE concentration versus time plot for MW-116 in Appendix B shows that the high coefficient of variation is in part attributable to the first sample result, which is approximately one order of magnitude higher than the subsequent results. It would seem reasonable to conclude that MW-116 exhibits stable PCE concentrations, as indicated by the Mann-Kendall statistical test. It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion.

TCE

Table 7 summarizes the results of applying the Mann-Kendall test to the TCE concentration data available for the monitoring wells listed in Table 5 that have four or more sample events. Of the 28 wells listed in Table 7, 27 exhibit either stable (no trend) or decreasing TCE concentration trends at greater than 90% confidence, consistent with plume stability.

Table 7 – Summary of Mann-Kendall (MK) test results for plume TCE concentrations

Well	MK Trend > 80% conf	MK Trend > 90% conf	CV if no trend at 80%
GEO-3	decreasing	no trend	n/a
GEO-6	decreasing	no trend	n/a
MW-101	no trend	no trend	< 1
MW-102	no trend	no trend	< 1
MW-103	no trend	no trend	< 1
MW-104	decreasing	decreasing	n/a

MW-105	no trend	no trend	< 1
MW-106	no trend	no trend	< 1
MW-107	no trend	no trend	< 1
MW-108	no trend	no trend	< 1
MW-111	decreasing	decreasing	n/a
MW-112A	increasing	increasing	n/a
MW-113	no trend	no trend	< 1
MW-114	no trend	no trend	< 1
MW-115R	no trend	no trend	< 1
MW-116	no trend	no trend	< 1
MW-117S	no trend	no trend	< 1
MW-117T	no trend	no trend	< 1
MW-117D	no trend	no trend	< 1
MW-118S	no trend	no trend	< 1
MW-118T	no trend	no trend	< 1
MW-118D	no trend	no trend	< 1
MW-119S	no trend	no trend	< 1
MW-119T	no trend	no trend	< 1
MW-120S	no trend	no trend	< 1
MW-120D	increasing	no trend	n/a
MW-201	no trend	no trend	< 1
MW-202	no trend	no trend	< 1

Table 7 indicates that MW-112A exhibits an increasing TCE concentration trend. Visual inspection of the TCE concentration versus time curve for MW-112A (Appendix B) indicates that the most recent sample result (April 2008) may represent a reversal of the prior trend. It is recommended that continued monitoring of this well be carried out to further evaluate the possibility of an increasing TCE concentration trend.

TCA

Table 8 summarizes the results of applying the Mann-Kendall test to the TCA concentration data available for the monitoring wells listed in Table 5 that have four or more sample events. Of the 28 wells listed in Table 8, all exhibit stable (no trend) or decreasing TCA concentrations at greater than 90% confidence, consistent with plume stability.

Table 8 shows that the coefficient of variation for MW-104 and MW-202 exceed unity, indicating that the no trend results may be influenced by data variability. Inspection of the TCA concentration versus time plot for MW-104 in Appendix B shows that the oscillating nature of the concentration versus time signature may be associated with seasonal effects. The two highest TCA concentrations were observed in the fall (October 2006 and October 2007) while the lower concentrations were observed in the April-May time frame. It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion.

With respect to monitoring well MW-202, inspection of the TCA concentration versus time plot (Appendix B) indicates that the high coefficient of variation is the result of the most recent sample point (35.2 ppb), which represents the highest concentration value exhibited by this

monitoring well. It is recommended that continued monitoring of this well be carried out to confirm the no trend conclusion.

Table 8 – Summary of Mann-Kendall (MK) test results for plume TCA concentrations

Well	MK Trend > 80% conf	MK Trend > 90% conf	CV if no trend at 80%
GEO-3	decreasing	no trend	n/a
GEO-6	no trend	no trend	< 1
MW-101	no trend	no trend	< 1
MW-102	no trend	no trend	< 1
MW-103	no trend	no trend	< 1
MW-104	no trend	no trend	> 1
MW-105	no trend	no trend	< 1
MW-106	no trend	no trend	< 1
MW-107	no trend	no trend	< 1
MW-108	no trend	no trend	< 1
MW-111	decreasing	decreasing	n/a
MW-112A	increasing	no trend	n/a
MW-113	no trend	no trend	< 1
MW-114	no trend	no trend	< 1
MW-115R	no trend	no trend	< 1
MW-116	no trend	no trend	< 1
MW-117S	no trend	no trend	< 1
MW-117T	no trend	no trend	< 1
MW-117D	no trend	no trend	< 1
MW-118S	no trend	no trend	< 1
MW-118T	no trend	no trend	< 1
MW-118D	no trend	no trend	< 1
MW-119S	no trend	no trend	< 1
MW-119T	no trend	no trend	< 1
MW-120S	no trend	no trend	< 1
MW-120D	decreasing	decreasing	n/a
MW-201	no trend	no trend	< 1
MW-202	no trend	no trend	> 1

3.3 – Plume Response Time

Evaluation of plume response time using the methodology presented in Section 2.2 requires estimation of chemical specific retardation factors using Equation (2). Kueper (2008a) calculated site specific retardation factors for PCE, TCE and TCA equal to 4.59, 3.16 and 3.54, respectively.

Estimating the plume response time using Equation (1) requires an estimate of the plume length (L). Inspection of groundwater quality data indicates that the length of the overburden plume is

between approximately 825 ft (distance from MW-1 to MW-116) and approximately 990 ft (distance from MW-3 to MW-118). An average overburden plume length of 900 ft (274 m) will be employed in this analysis.

Estimating the plume response time using Equation (1) also requires an estimate of the average linear groundwater velocity (v) as given in Equation (5). Equation (5) shows that the average linear groundwater velocity requires knowledge of the hydraulic conductivity, the hydraulic gradient, and the porosity. Table 9 presents a summary of hydraulic conductivity measurements available for the Site. The geometric mean of the 19 overburden hydraulic conductivity measurements is $9.64\text{E-}04$ cm/s. With respect to the hydraulic gradient, groundwater contour maps (GEI, 2007) prepared for the 07/16/2007, 08/22/2007 and 09/27/2007 waterlevel monitoring events indicate that the hydraulic gradient as calculated between monitoring wells SH-1 and MW-118S (distance interval deemed to be representative of hydraulic gradients within the plume) was 0.00788, 0.00622 and 0.00655, respectively. The arithmetic mean of these three values (0.00688) will be employed in this analysis. With respect to the aquifer porosity, a value of 0.25 is deemed to be representative and is characteristic of the overburden materials (Freeze and Cherry, 1979). Using the above values, the average linear groundwater velocity is estimated to be $2.65\text{E-}05$ cm/s (27 ft/yr) as calculated using Equation (5).

Using an average linear groundwater velocity of $2.65\text{E-}05$ cm/s, a plume length of 900 ft (274 m), and a retardation factor of 4.59, the estimated PCE plume response time is calculated to be 151 years. Using a retardation factor of 3.16, the corresponding TCE plume response time is calculated to be 104 years. Using a retardation factor of 3.54, the corresponding TCE plume response time is calculated to be 116 years.

Table 9 – Summary of Hydraulic Conductivity Measurements

Well Name	Geology	K (cm/s)
GEO-1	Overburden	2.21E-03
GEO-2	Overburden	1.57E-03
GEO-3	Overburden	5.13E-05
GEO-5	Overburden	9.82E-05
GEO-6	Overburden	1.68E-05
MW-101	Overburden	8.21E-04
MW-102	Overburden	6.33E-05
MW-111	Overburden	5.87E-03
MW-112A	Overburden	1.05E-04
MW116	Bedrock	2.20E-02
MW117S	Overburden	4.72E-05
MW117T	Till	4.46E-04

MW118S	Overburden	1.22E-02
MW118T	Till	1.44E-03
MW119S	Overburden	3.67E-02
MW119T	Till	6.13E-02
MW120D	Bedrock	5.42E-04
MW121S	Overburden	7.51E-03
MW-201	Overburden	6.82E-03
MW-202	Overburden	2.76E-03
SH-MW3	Overburden	4.47E-04

NOTE: Arithmetic mean K value listed where two tests performed in a well

In addition to the use of Equation (1), the plume response time is estimated here using the batch flushing model described by Equation (4). Equation (4) also requires that both the initial (C_o) and target level (C) concentrations be specified. The values of C_o are estimated here using groundwater quality data only from monitoring wells outside of the source zone (i.e., not using the monitoring wells listed in Table 1) and using groundwater quality data only from monitoring wells within the well defined interior of the plume. Monitoring wells outside of the well defined interior of the plume are deemed to be those located along Alston Street (MW-114, MW-115, MW-115R), north of the 50 Tufts Street property (MW-105, MW-202, MW-201), along Dell Street (MW-106, MW-107, MW-108), north of the Michael E. Capuano Center (MW-120, MW-119), and those wells at the fringes of the plume (MW-113, MW-121, MW-118, and MW-117). The resulting values of C_o for PCE, TCE and TCA for use in Equation (4) are summarized in Table 10. These values were arrived at by first calculating the average PCE, TCE and TCA concentrations in each of the listed wells, and then calculating the mean of these averages. The individual well concentration averages were calculated first to account for the fact that not all of the wells listed in Table 10 have the same number of sample events.

**Table 10 – Historical average concentrations (ppb) reflective of plume interior
(using data up to January 2008)**

Monitoring Wells Used to Calculate Average Concentration	Historical Average PCE Concentration	Historical Average TCE Concentration	Historical Average TCA Concentration
MW-101	142.14	42.4	96.1
GEO-3	1431.6	147.38	55
MW-109	103.25	2.75	0.87
GEO-6	825.42	84.22	36.35
MW-203	15500	979	1710
MW-104	61.63	52.55	50.93
MW-110	0.91	1	1
MW-102	517.90	48.01	45.34

MW-103	1443.67	54.51	16.06
MW-111	7772.00	104.3	82.6
MW-112A	224.20	60.02	2.02
MW-116	332.64	131.86	10.59
Overall Mean:	2362.94	142.33	175.57

Equation (4) is implemented here using values of $L = 274$ m (900 ft), $v = 2.65\text{E-}07$ m/s, and the C_o values listed in Table 10. Figure 1 illustrates the relationship between the target concentration (C) and the time required to reach this concentration. Figure 1 illustrates that the time to reach a particular target concentration is higher for PCE than the other two compounds of interest. This stems from the fact that the initial PCE concentrations are higher than those for TCE and TCA, and from the fact that PCE has a higher retardation factor (which governs desorption rates).

The results of employing Equations (1) and (4) to evaluate plume response time can be viewed as screening level assessments. The results of these calculations indicate that plume response in overburden is expected to be slow because of the overall low to moderate hydraulic conductivity, the moderate degree of sorption, and the lack of aggressive biodegradation.

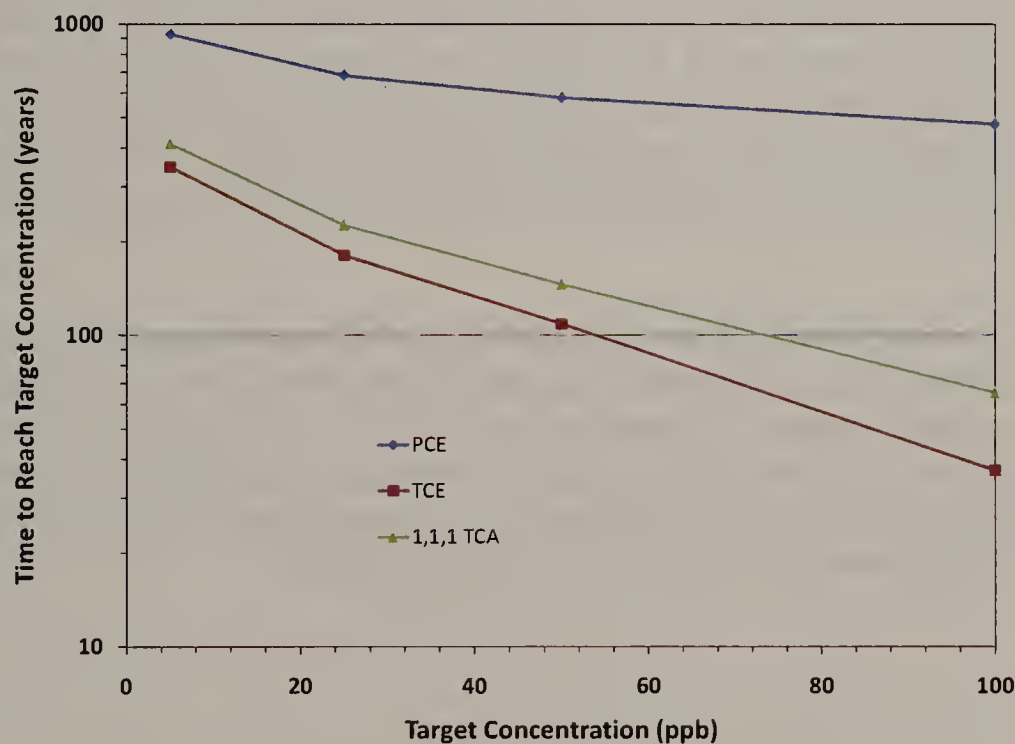


Figure 1 – Time to reach target concentration calculated using batch flushing model

4.0– Conclusions

Source Stability

It is concluded on the basis of the Mann-Kendall analysis that the sources of PCE, TCE and TCA at the 50 Tufts Street Site are stable. The Mann-Kendall analysis indicated that eight of nine source zone monitoring wells exhibited either stable or decreasing PCE concentration trends, nine of nine source zone monitoring wells exhibited either stable or decreasing TCE concentration trends, and nine of nine source zone monitoring wells exhibited either stable or decreasing TCA concentration trends. It is recommended that monitoring wells GEO-1 and GEO-2 continue to be sampled given that the coefficient of variation for some chemicals exceeded unity.

Plume Stability

It is concluded on the basis of the Mann-Kendall analysis that the PCE, TCE and TCA plumes are stable throughout the available network of monitoring wells. The Mann-Kendall analysis indicated that 28 of 28 plume monitoring wells exhibited either stable or decreasing PCE concentration trends, 27 of 28 plume monitoring wells exhibited either stable or decreasing TCE concentration trends, and 28 of 28 plume monitoring wells exhibited a stable or decreasing TCA concentration trends. It is recommended that regular monitoring of MW-112A be carried out given that the Mann-Kendall test indicated an increasing TCE concentration trend in this well. It is also recommended that monitoring wells MW-104, MW-112A, MW-116 and MW-202 continue to be sampled given that the coefficient of variation for some chemicals exceeded unity.

Plume Response Time

It is concluded on the basis of screening level calculations that plume response in overburden is expected to be slow (on the order of decades) because of the overall low to moderate hydraulic conductivity, the moderate degree of sorption, and the lack of aggressive biodegradation. Response of the PCE plume to source isolation and/or removal is expected to be slower than that for TCE and TCA because of the initially higher PCE concentrations within the interior of the off-site plume and the higher retardation factor associated with PCE.

References

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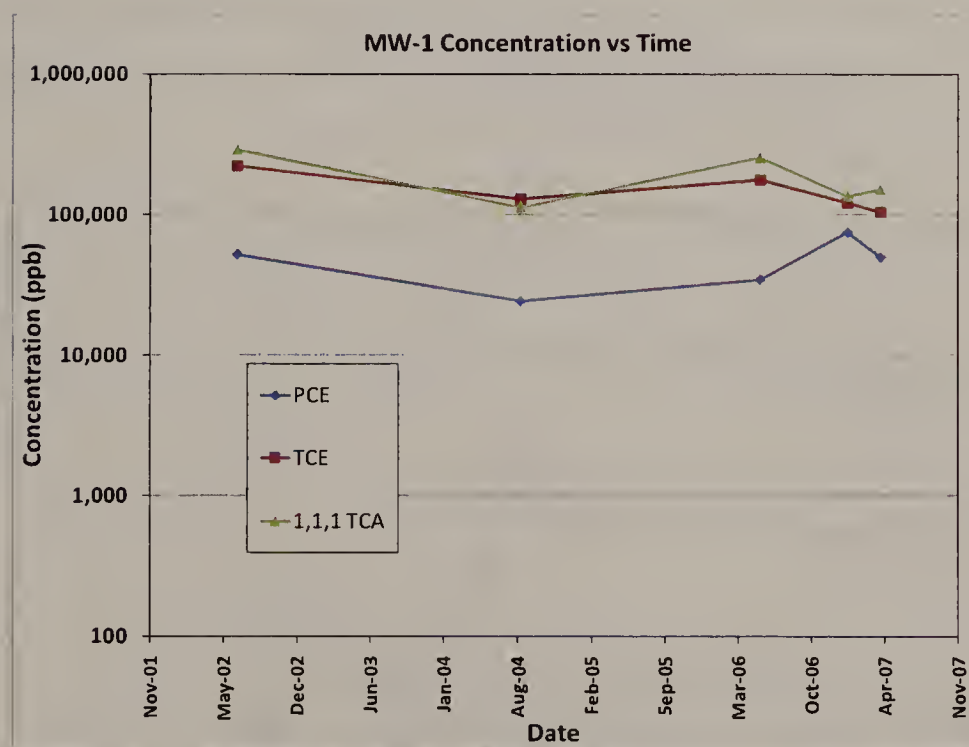
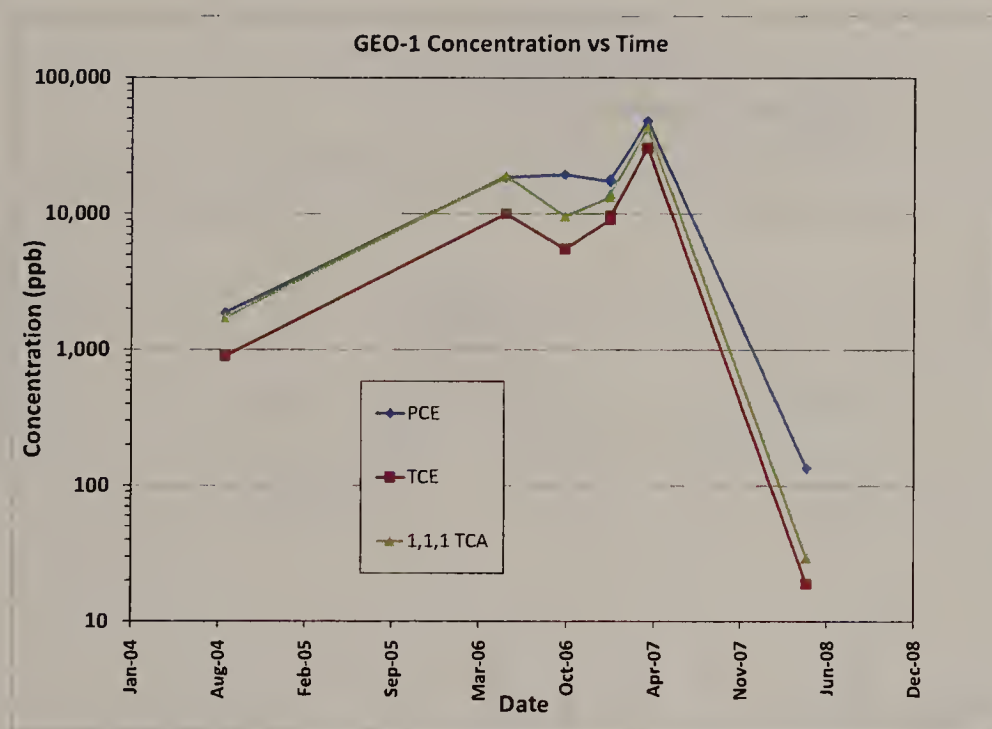
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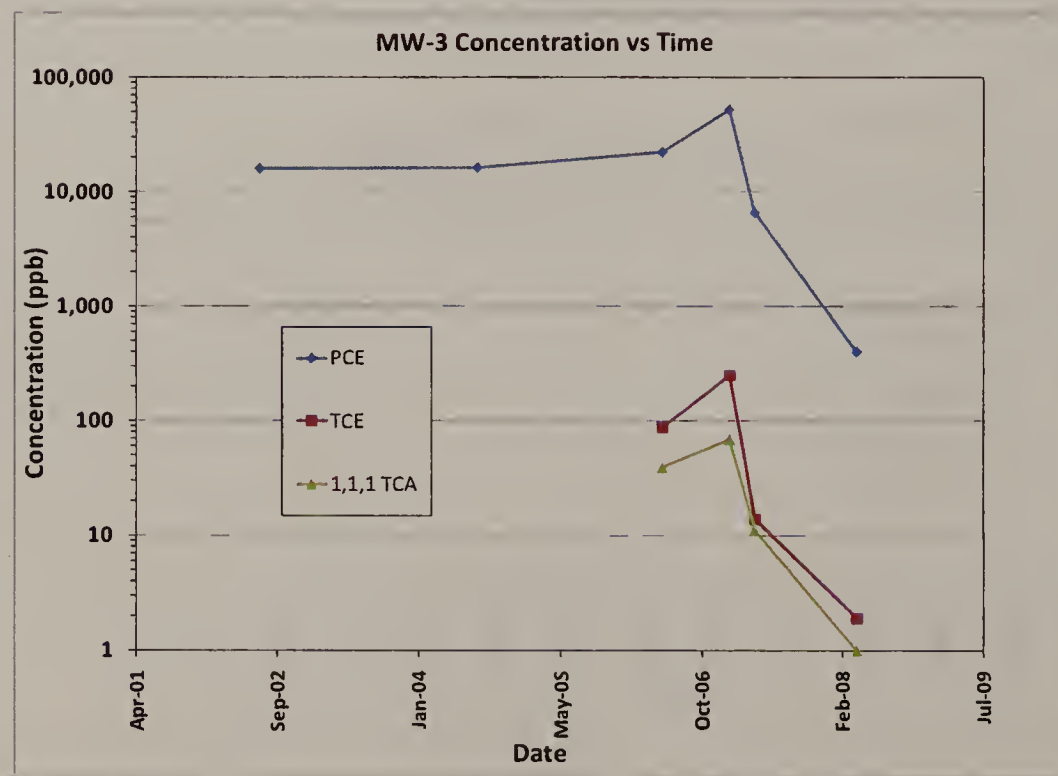
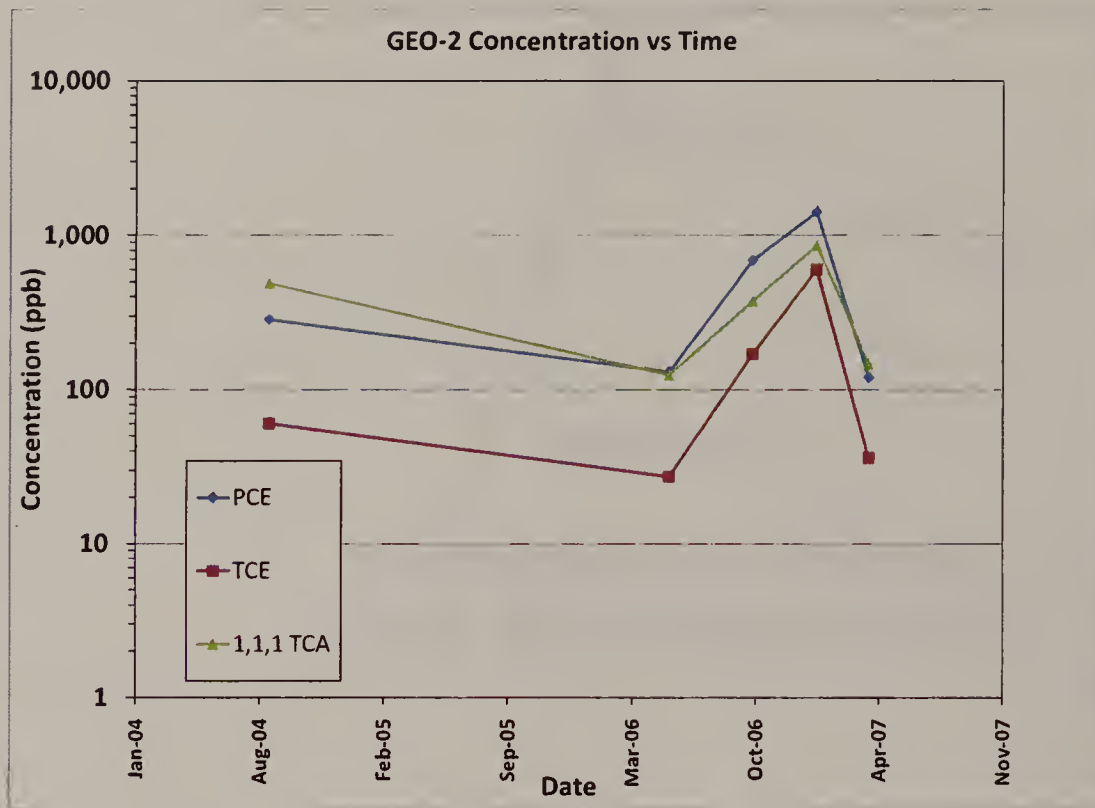
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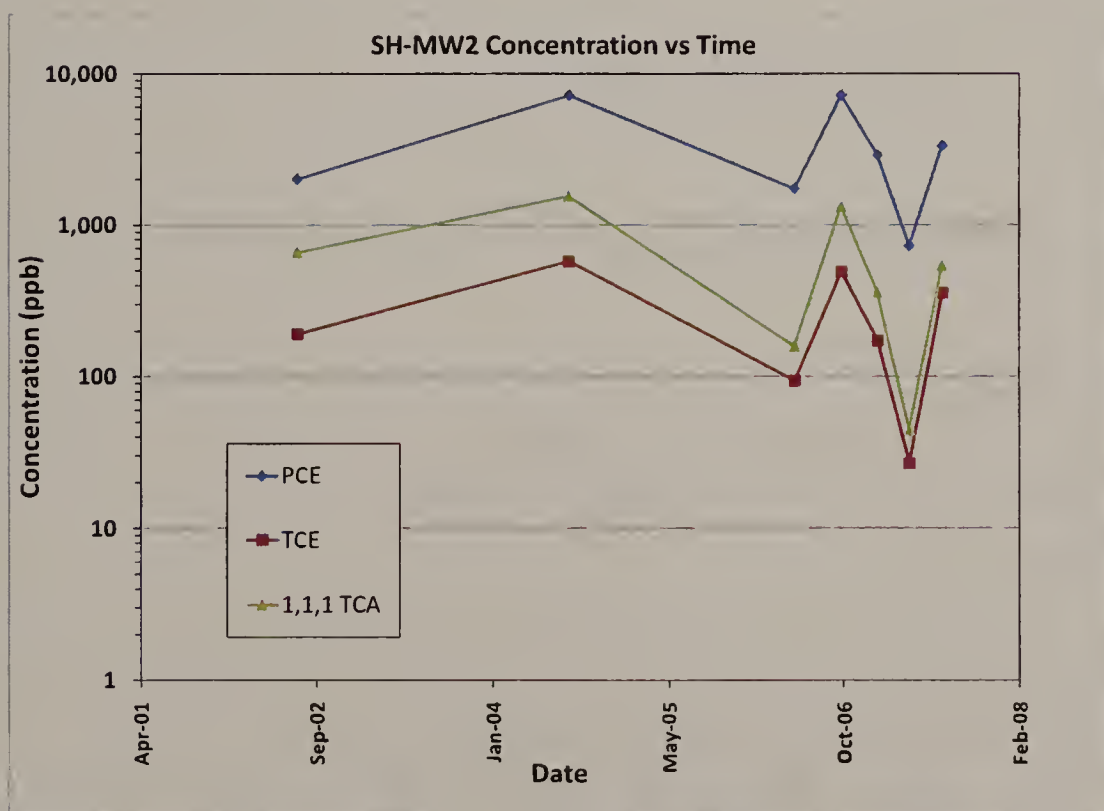
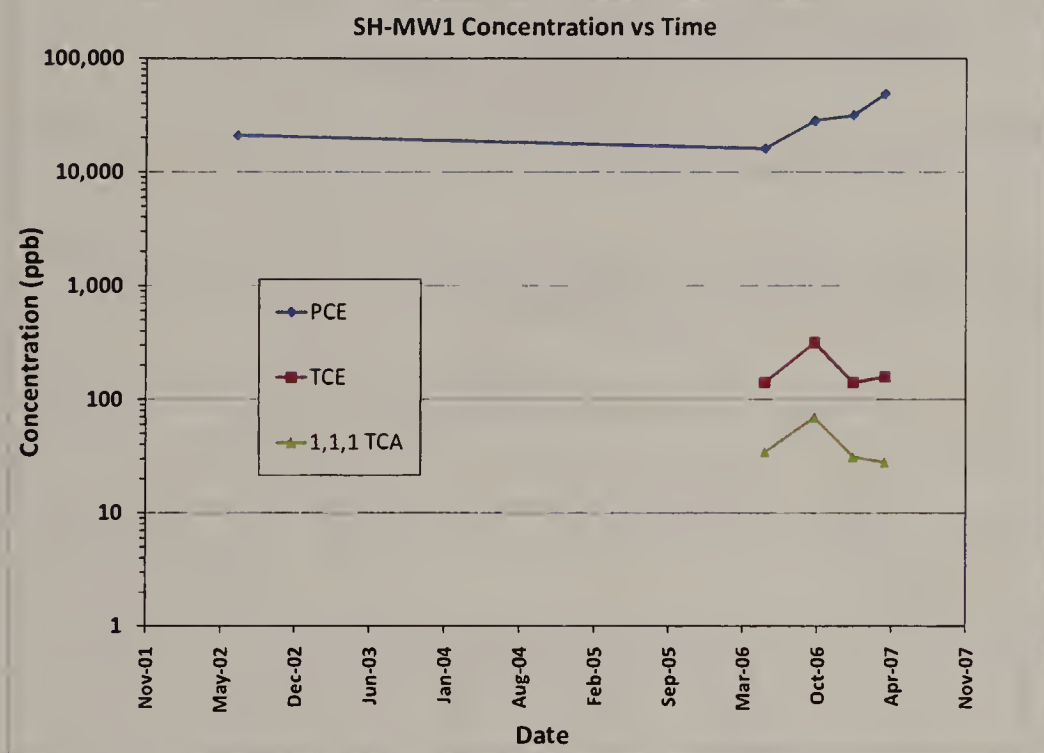
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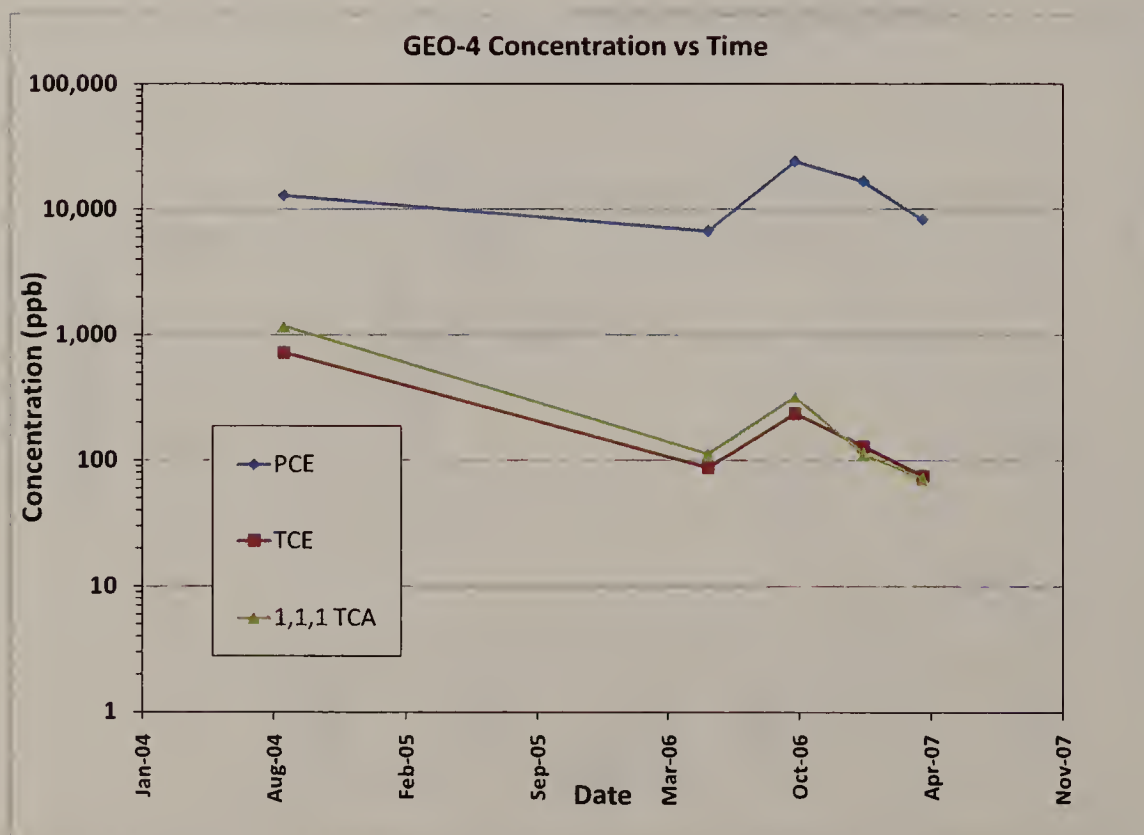
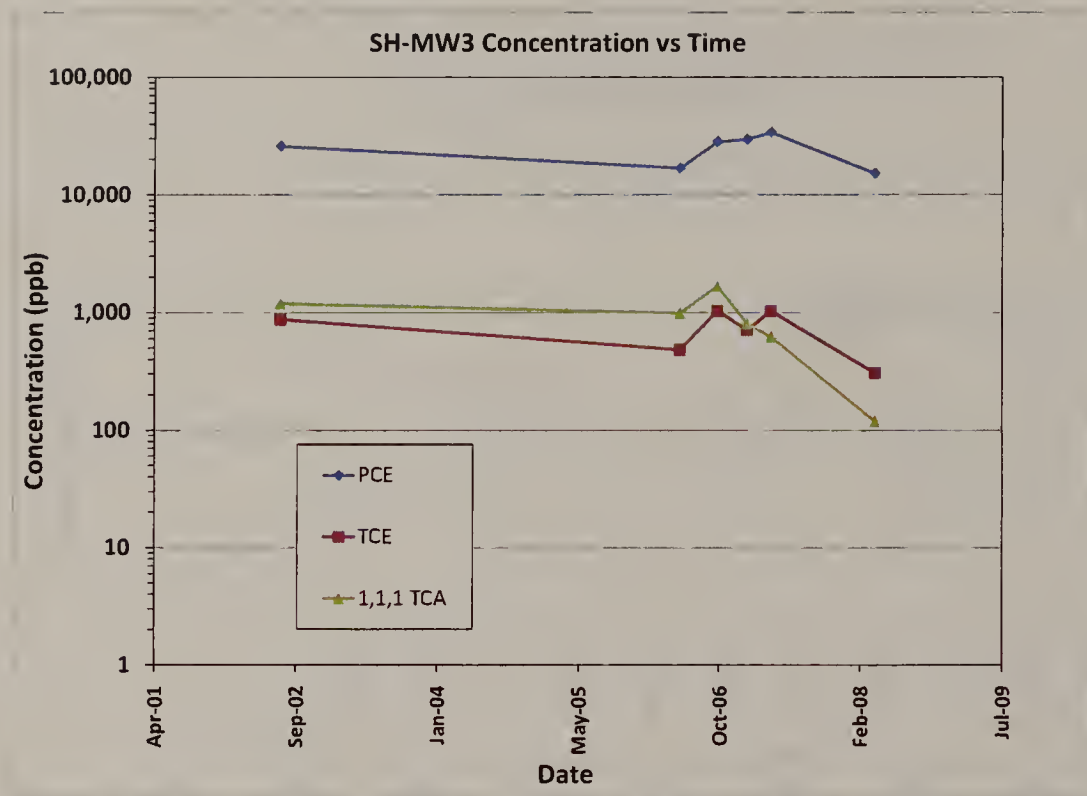
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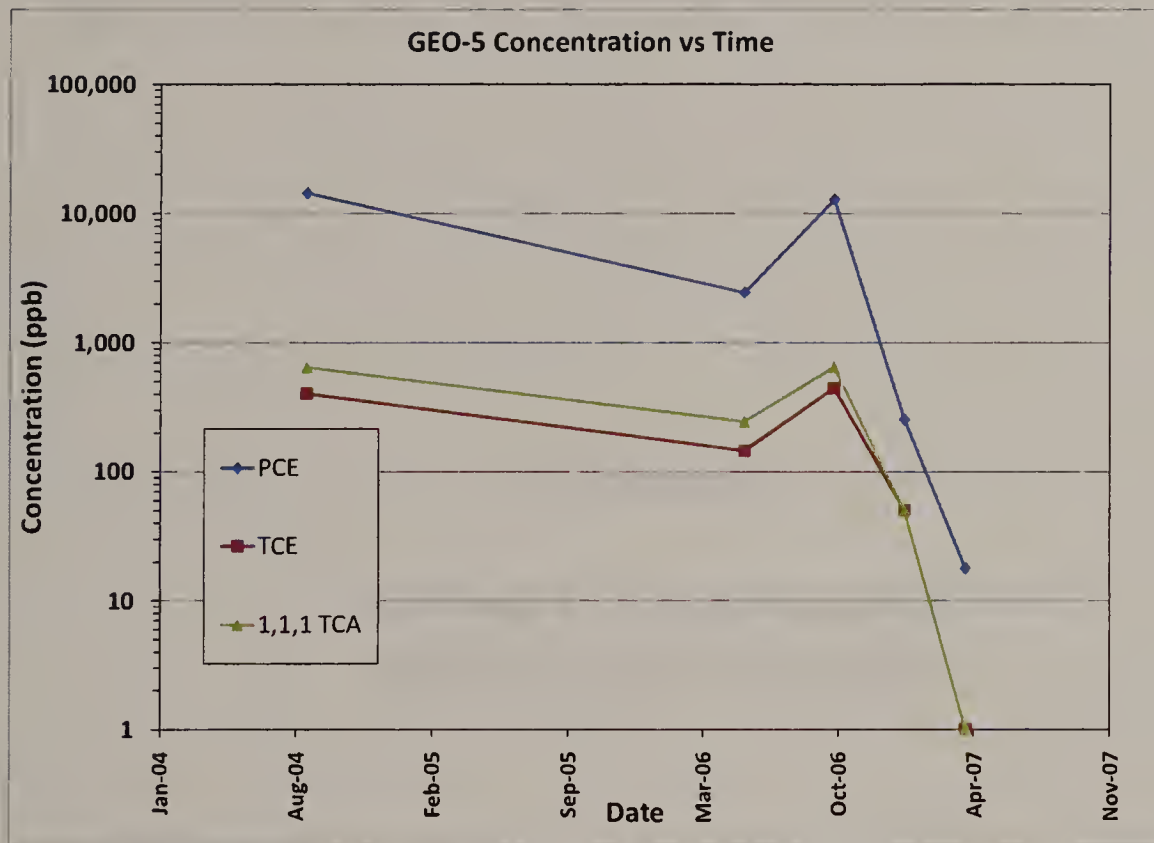
Concentration vs Time Plots Source Zone Monitoring Wells





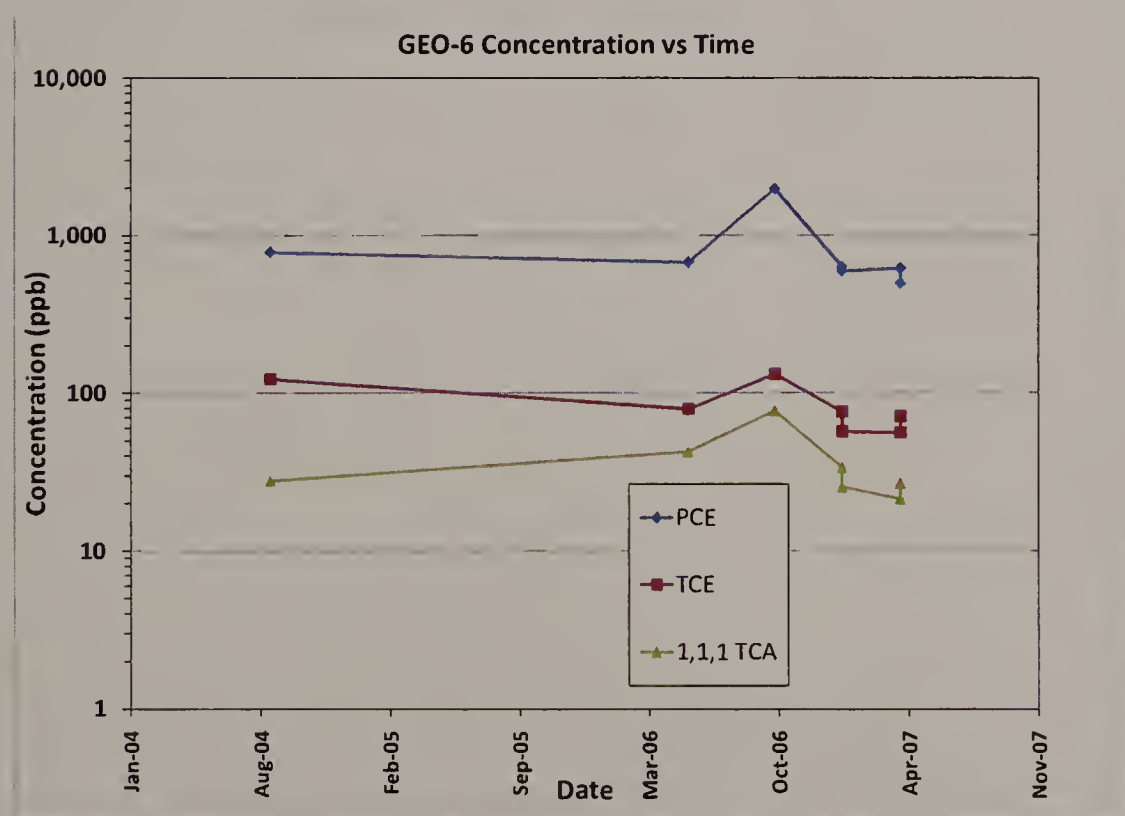
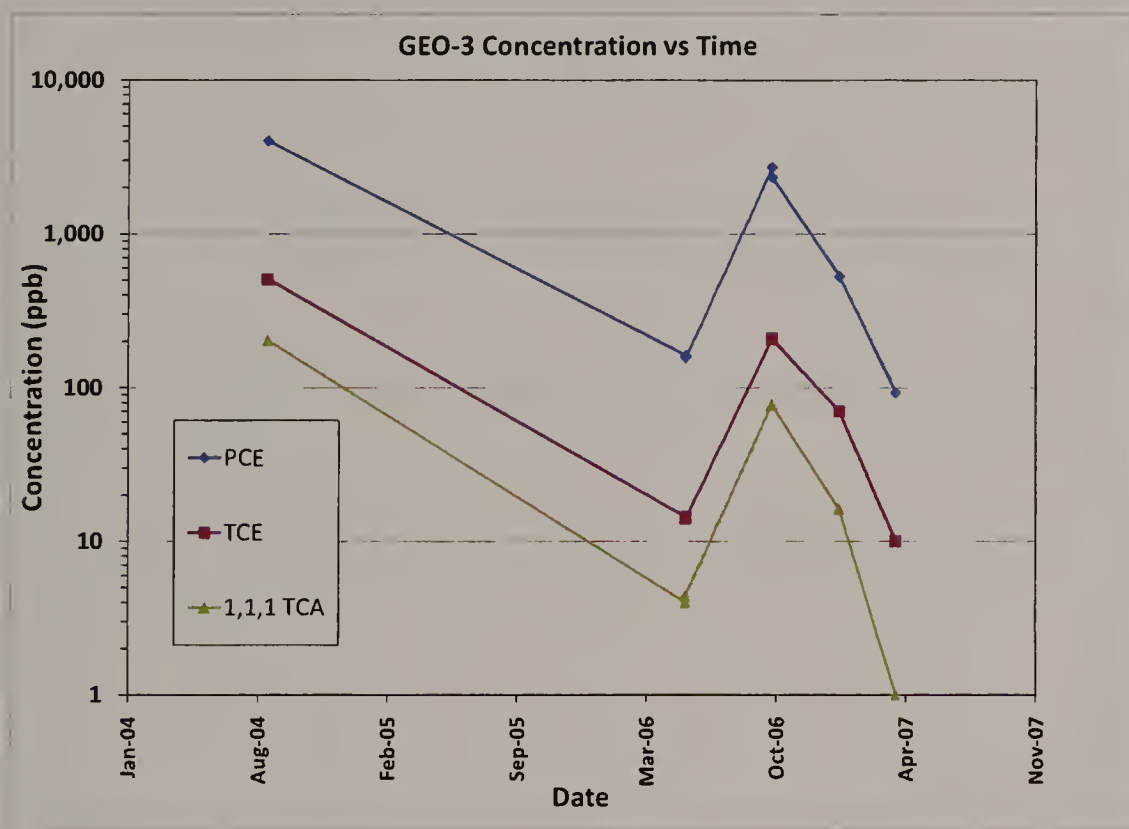


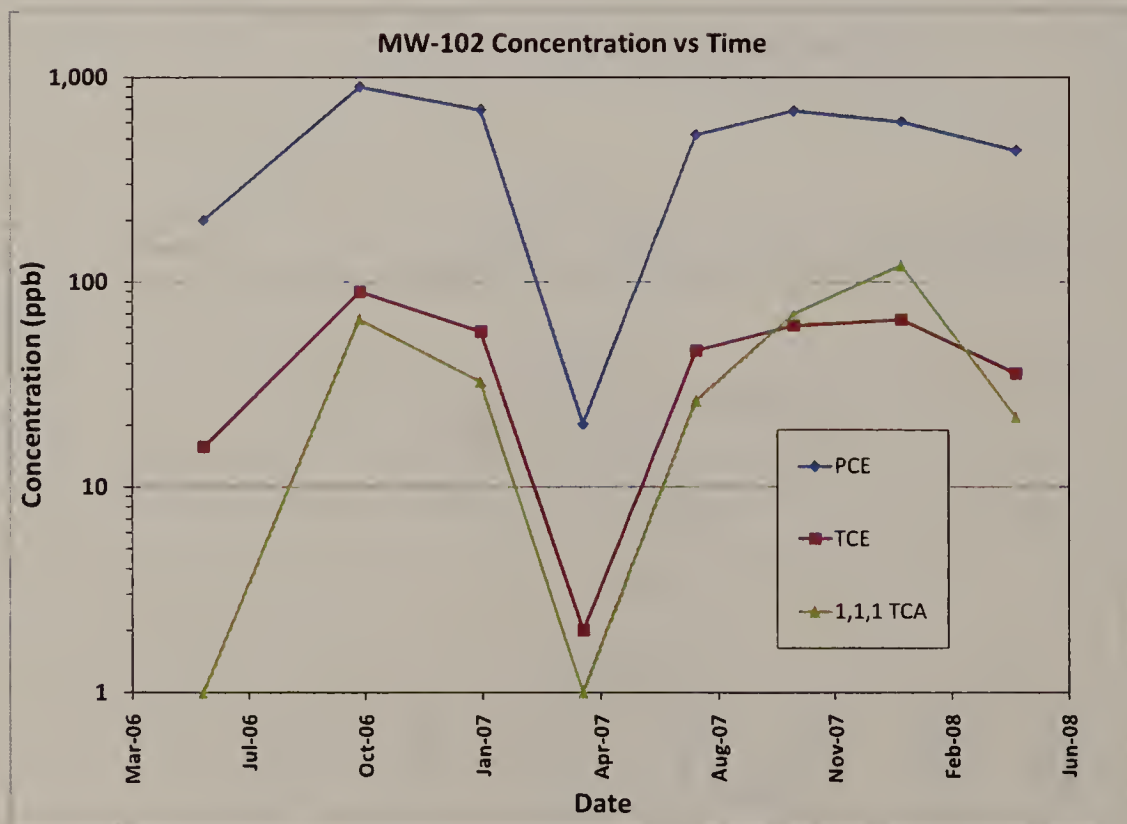
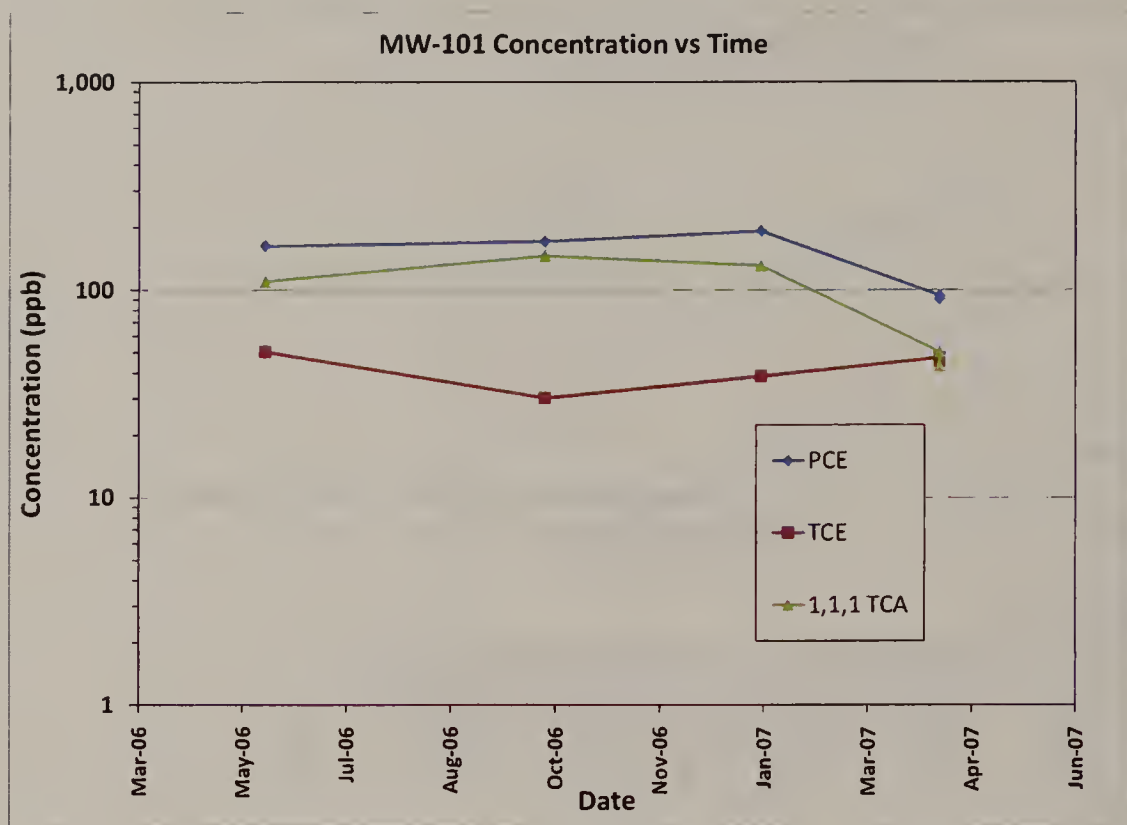


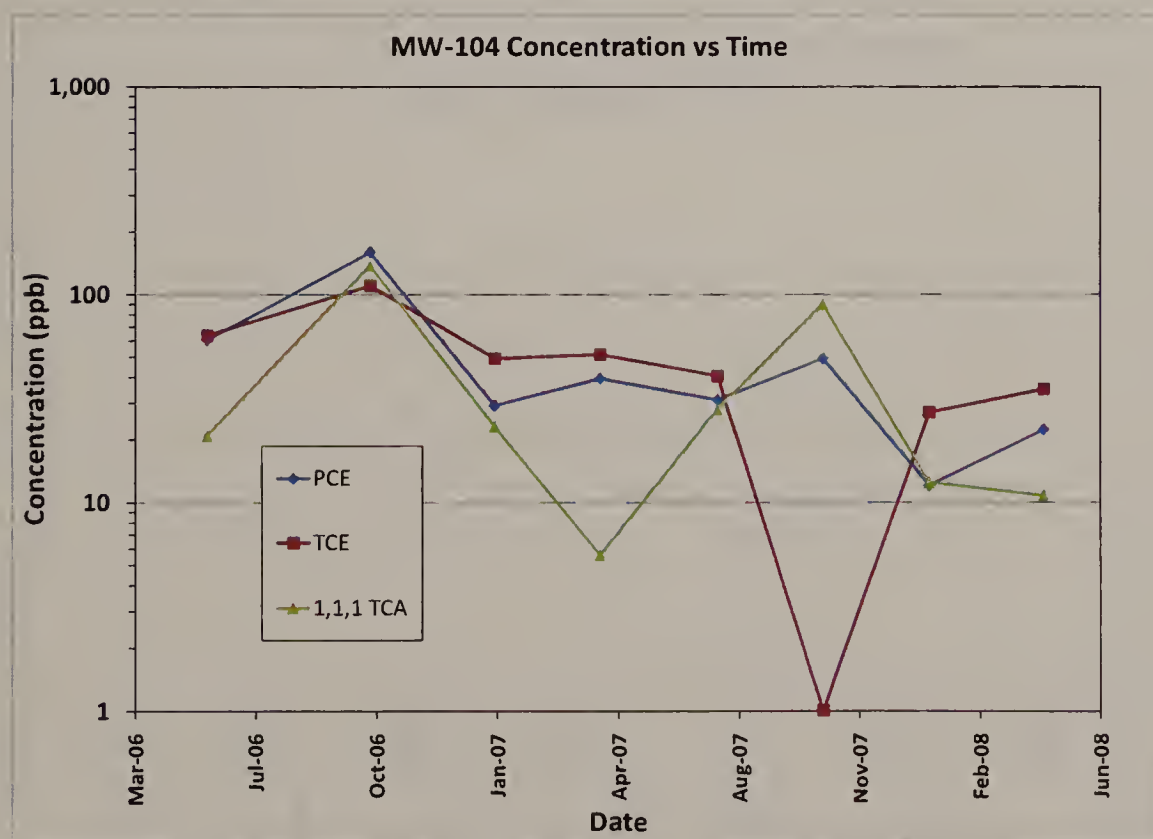
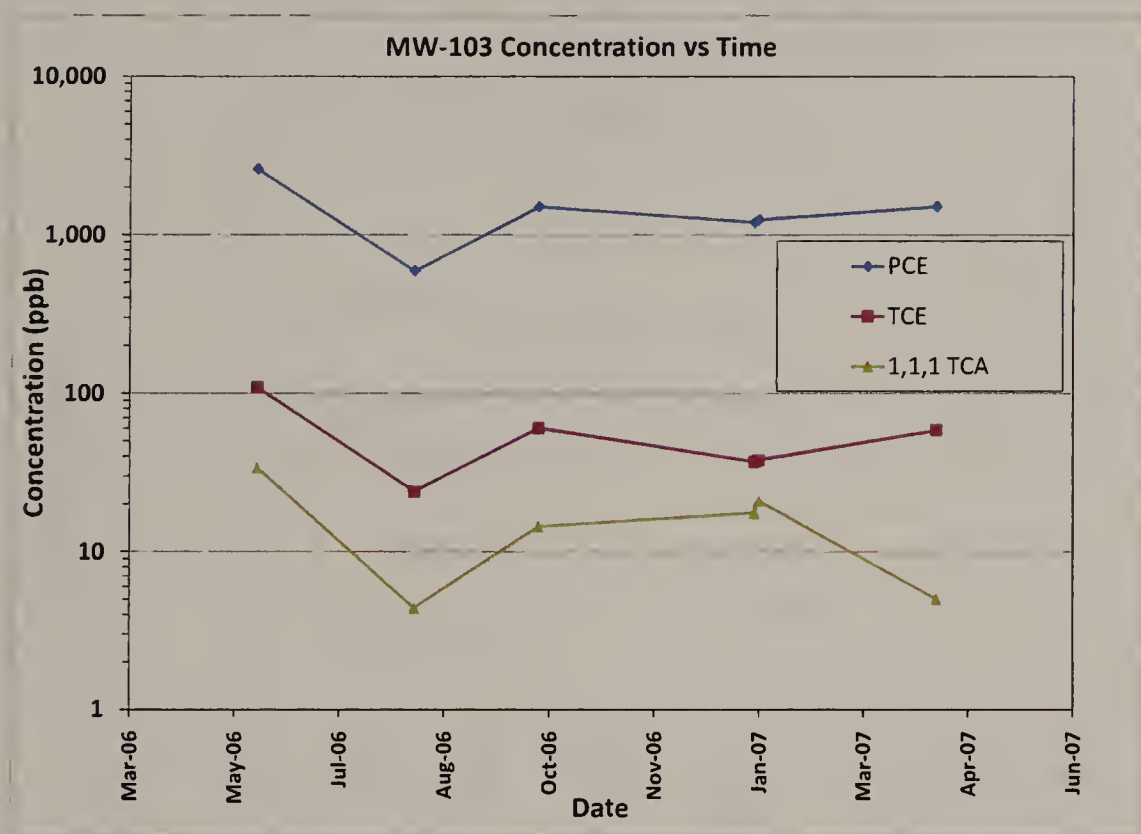


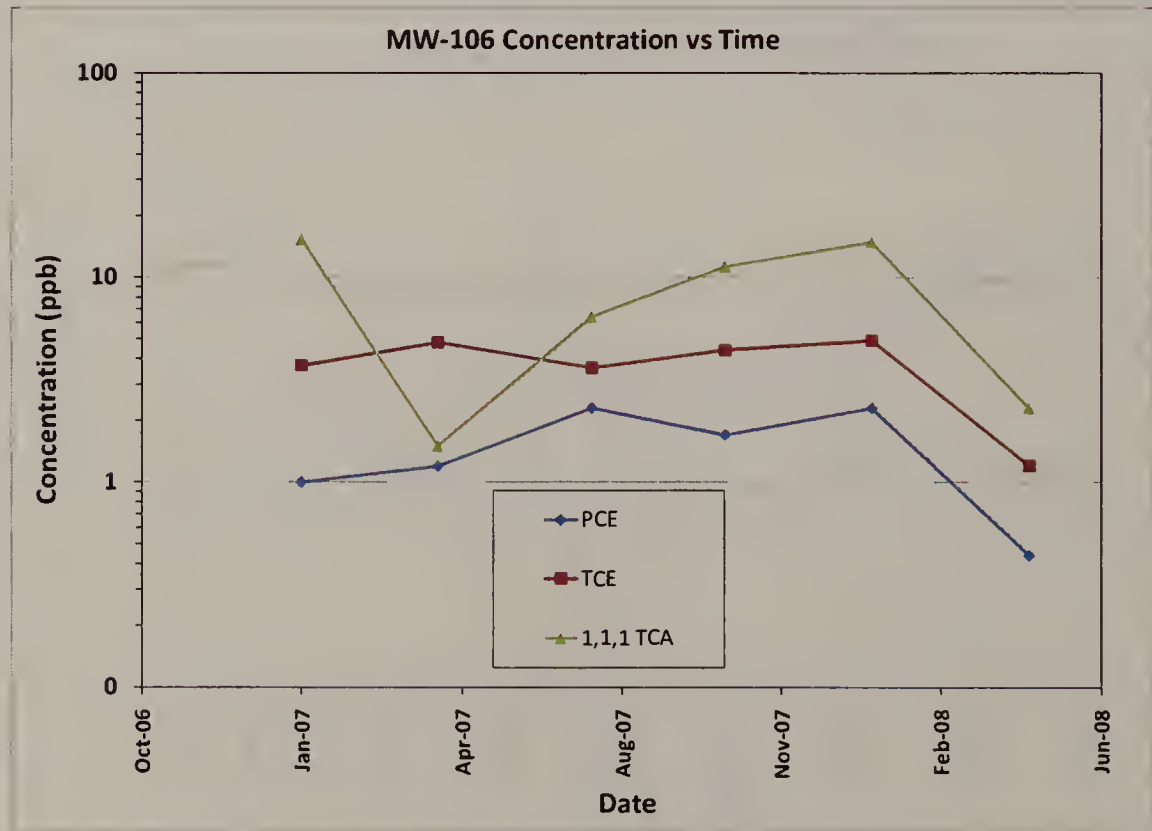
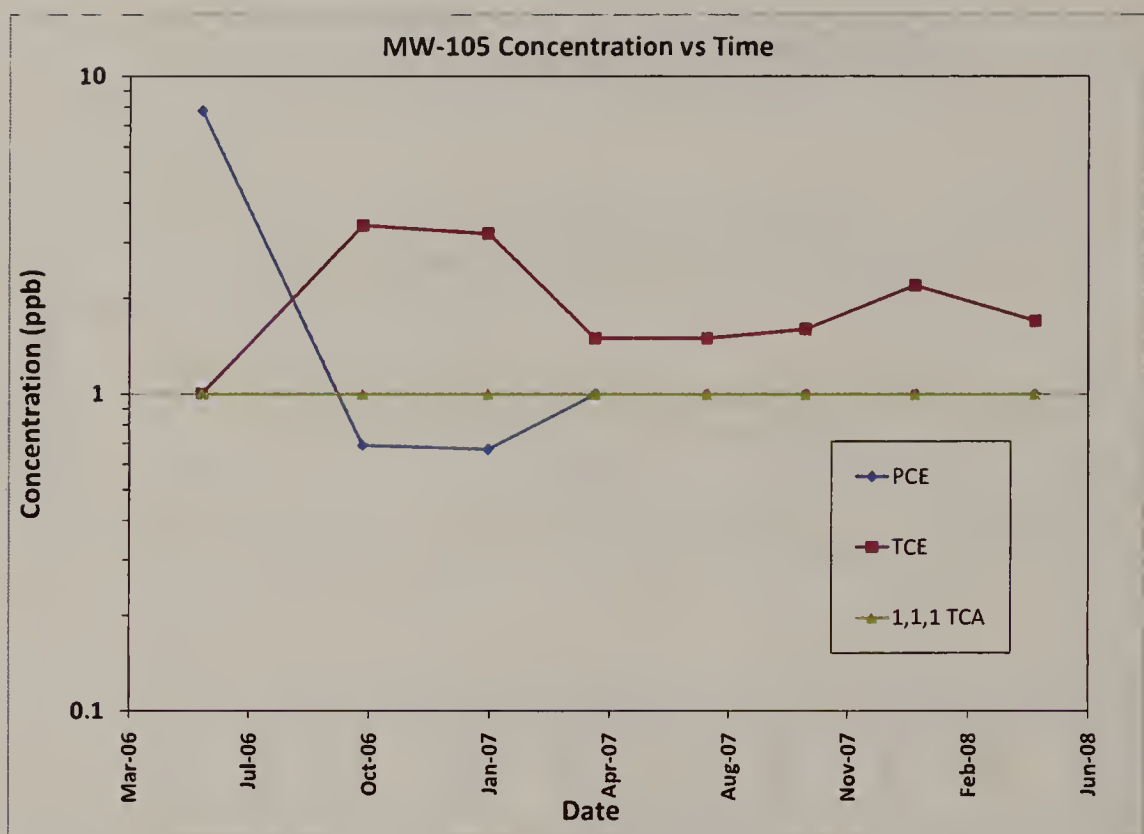
Appendix B

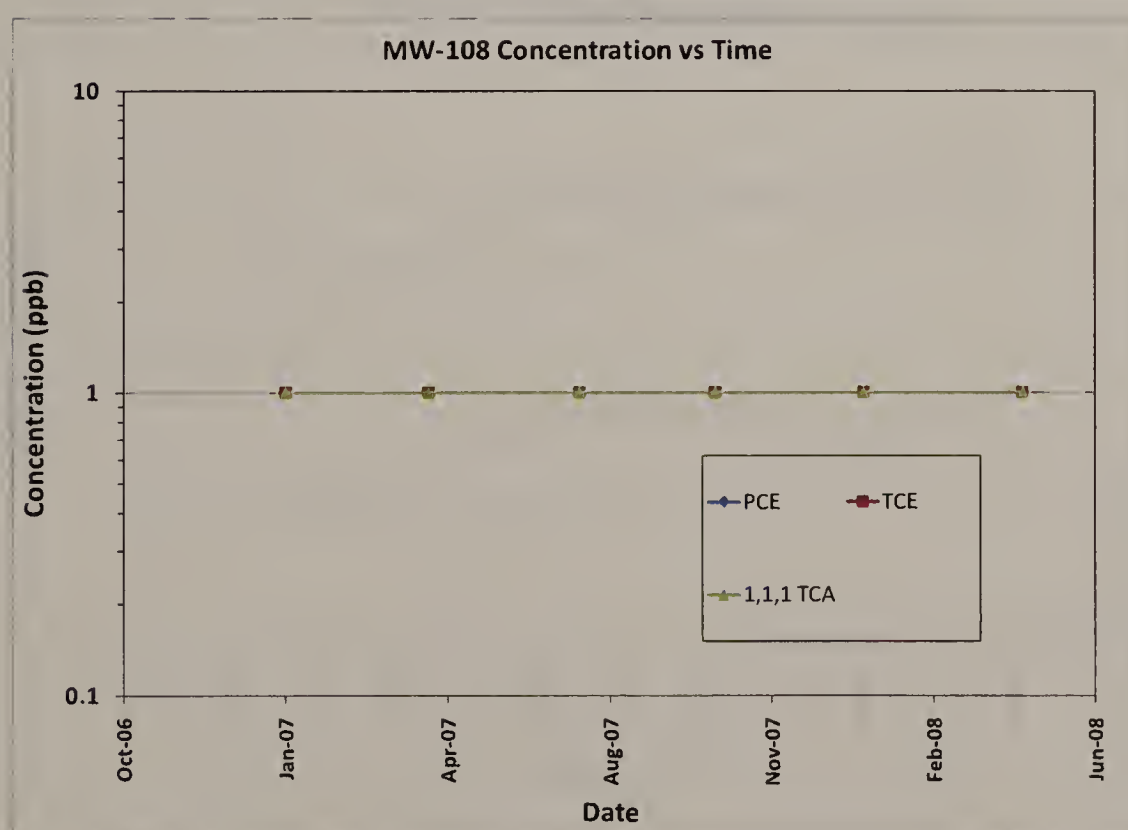
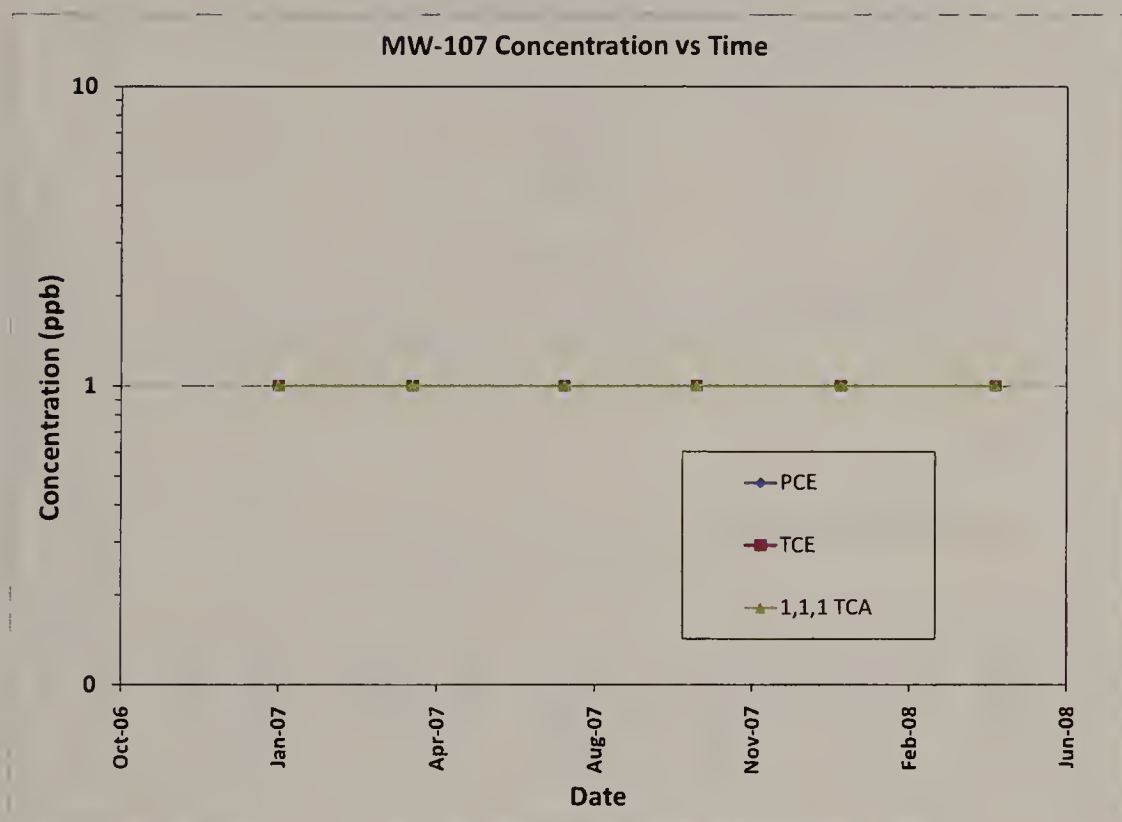
Concentration vs Time Plots Plume Monitoring Wells

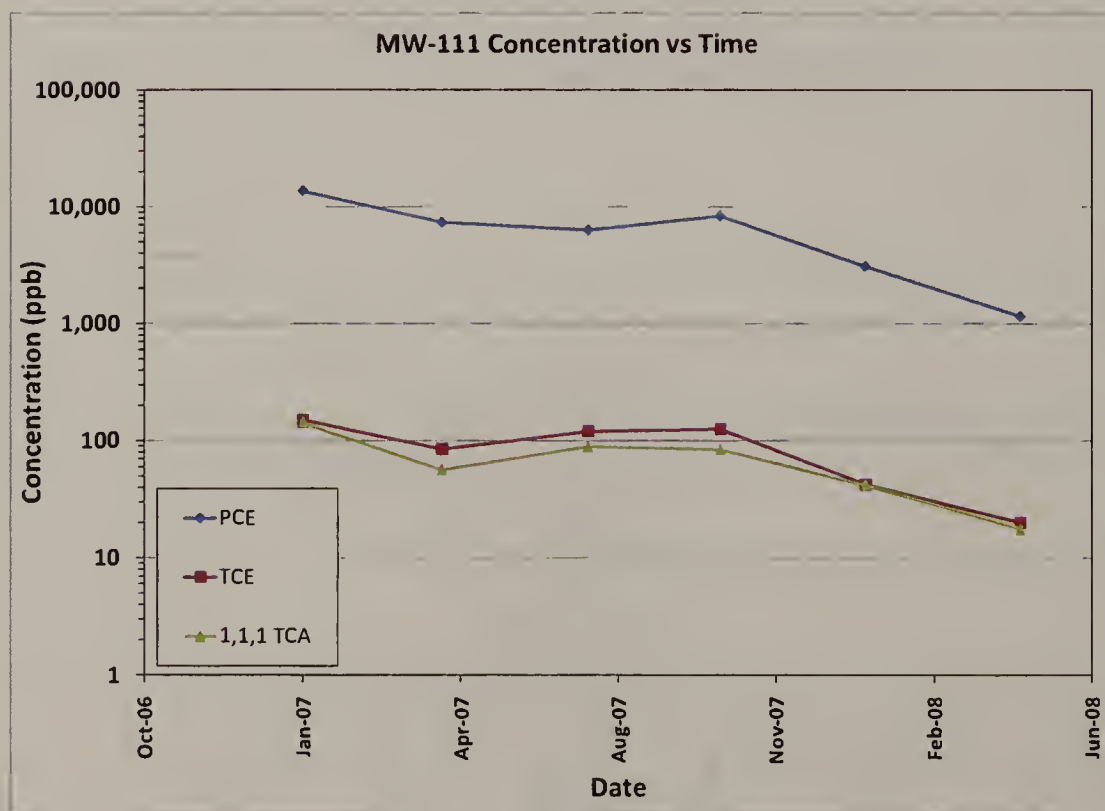
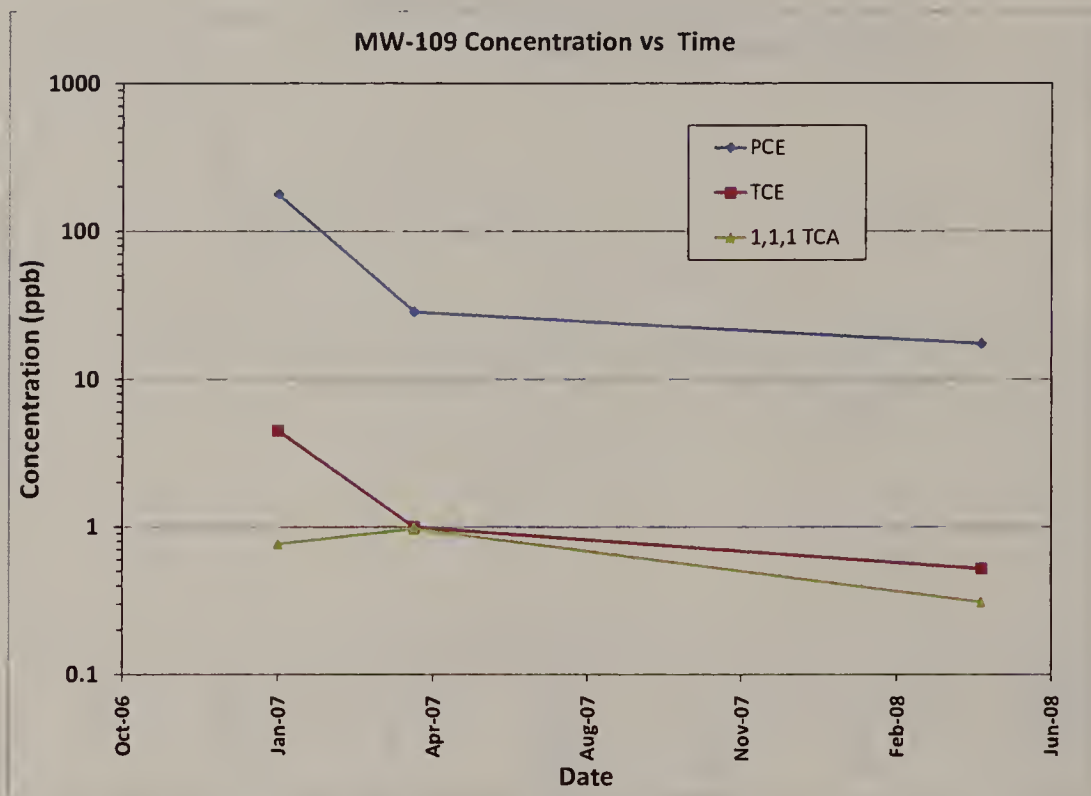


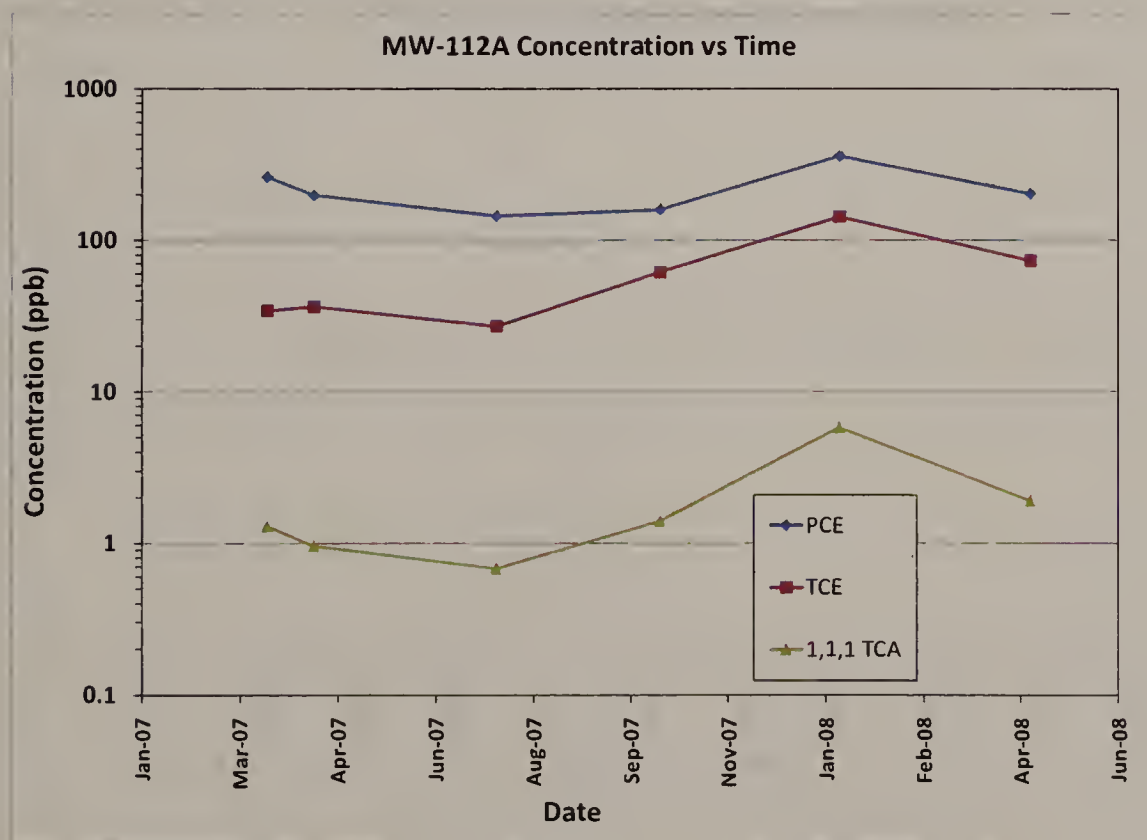
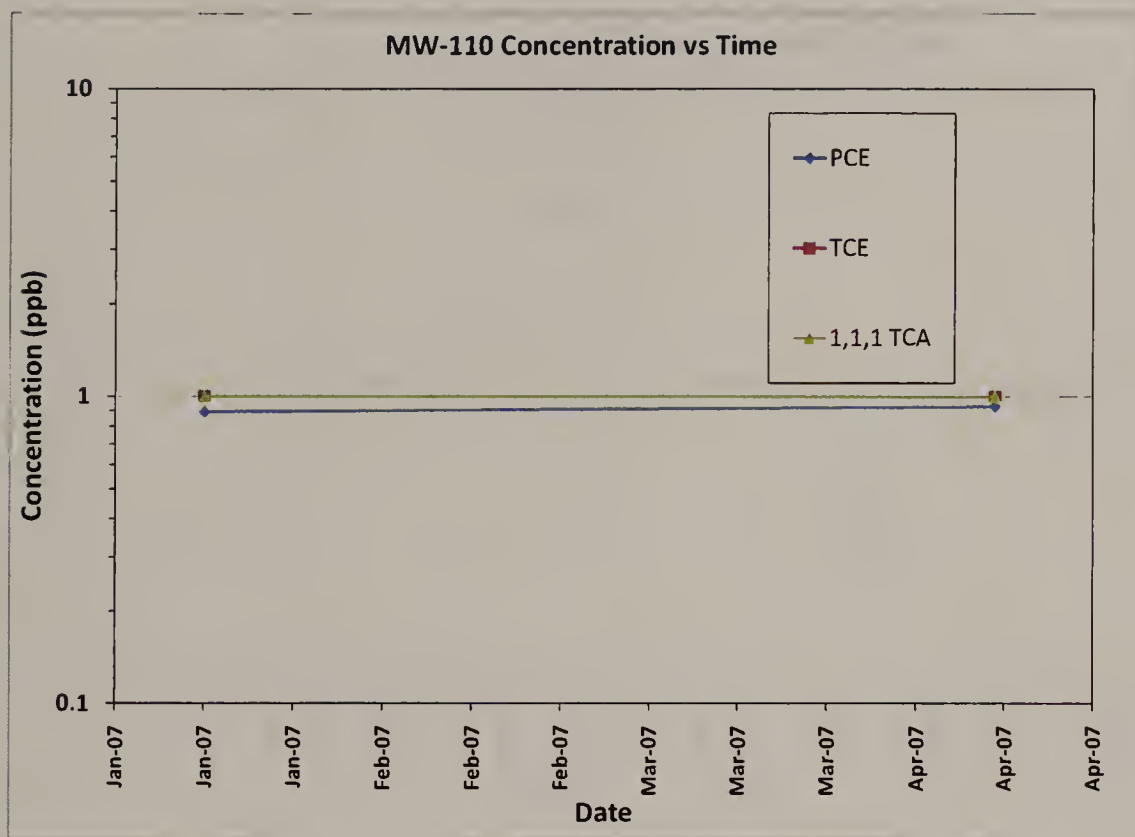


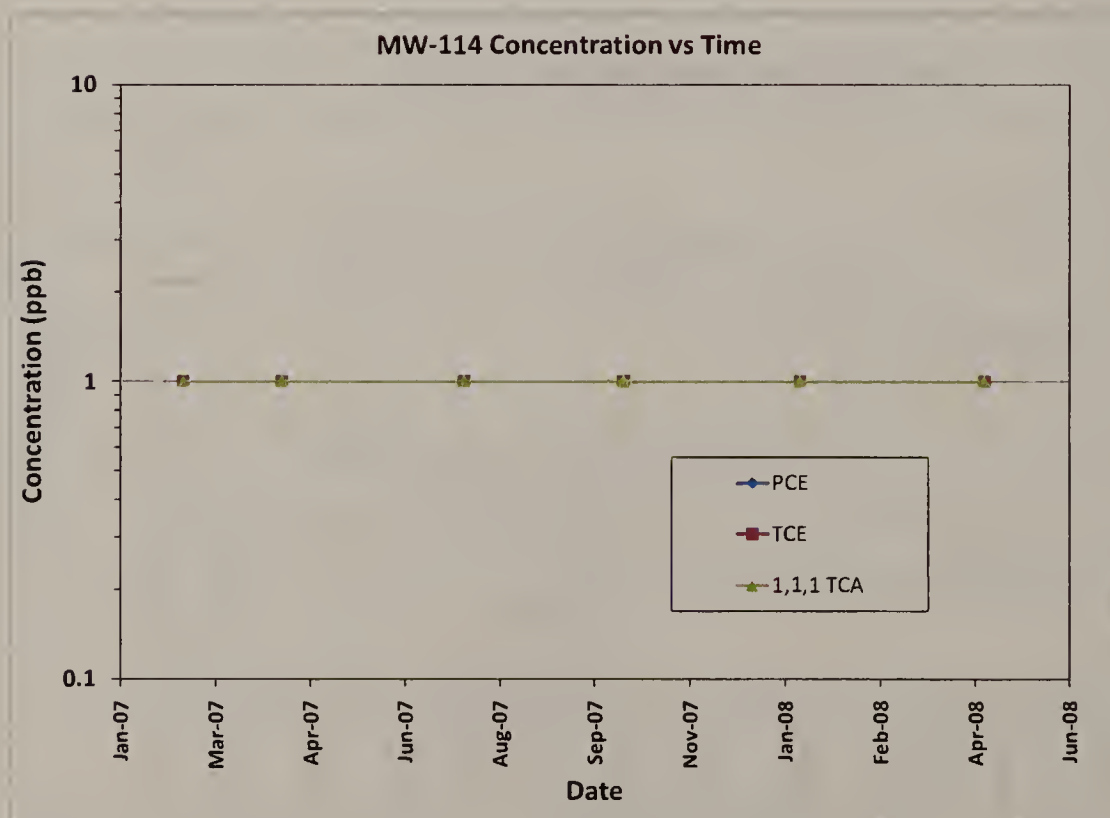
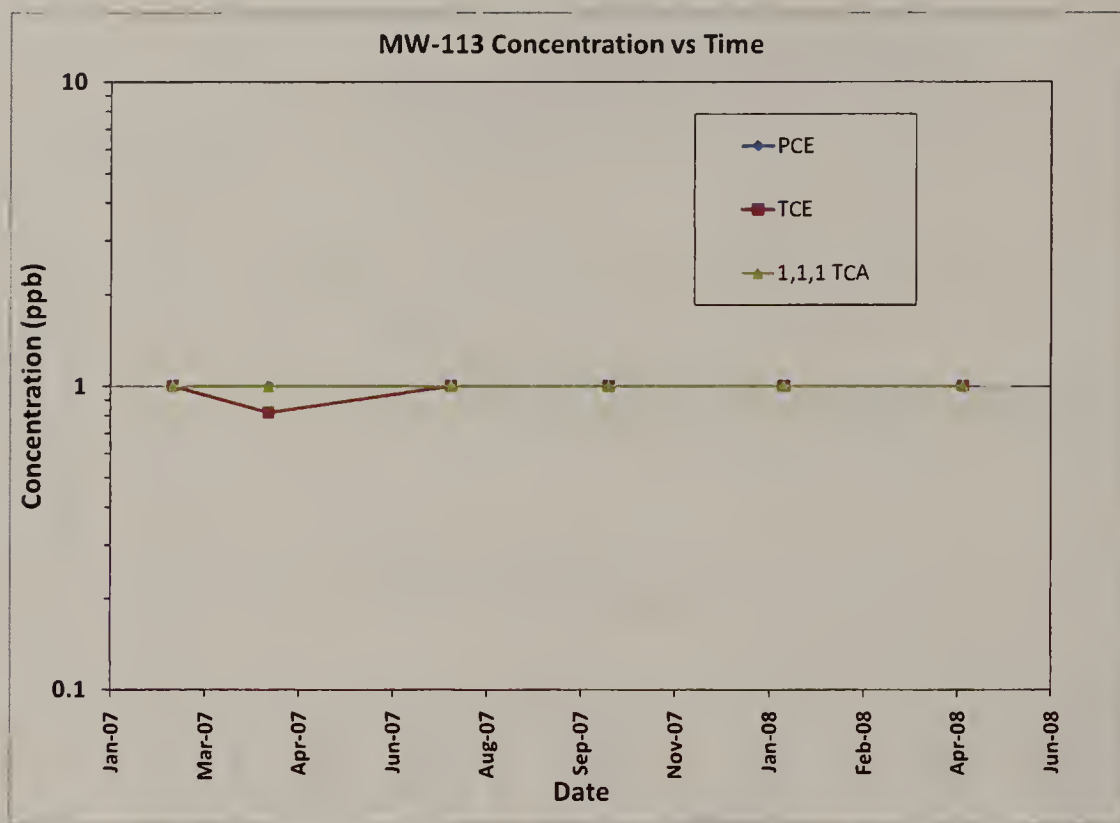


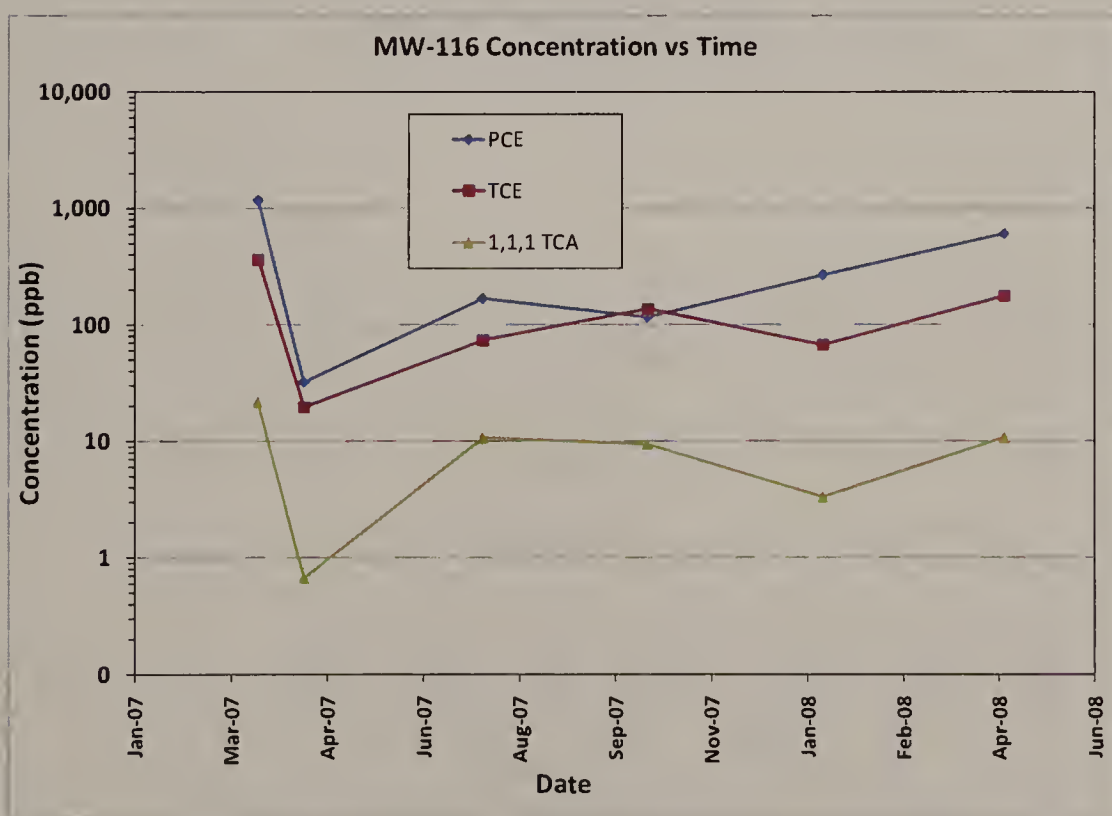
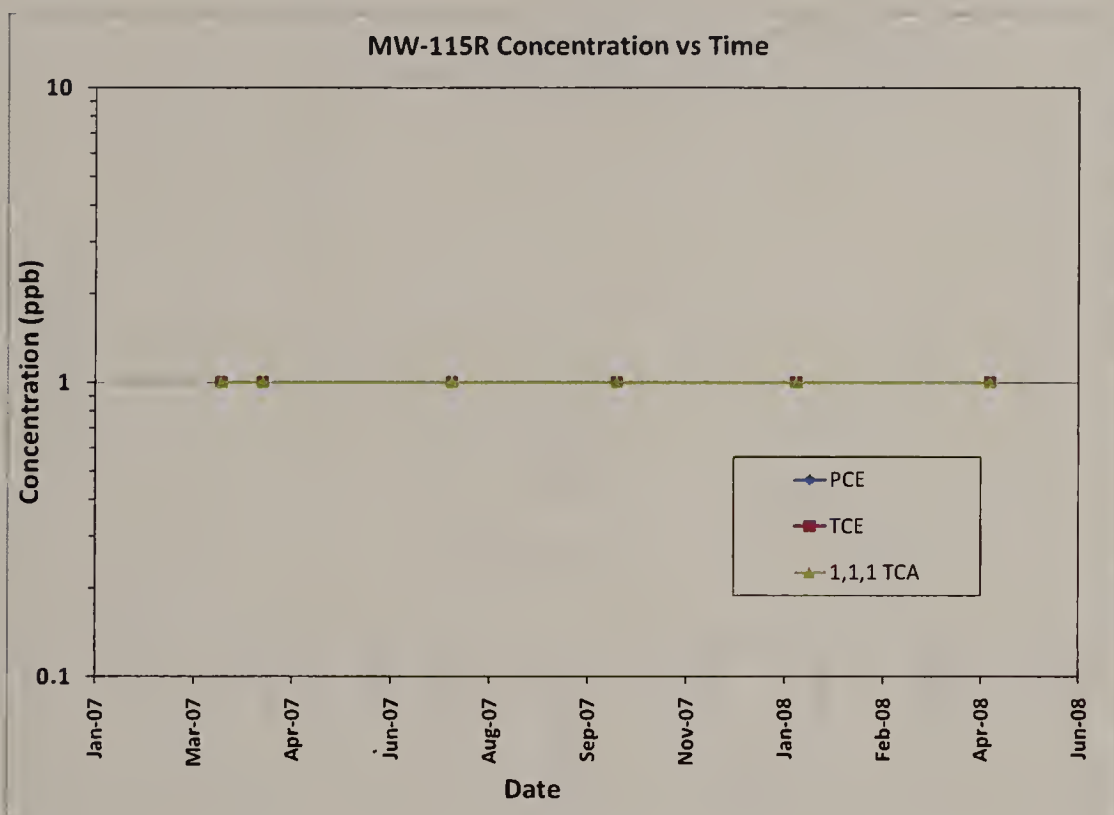


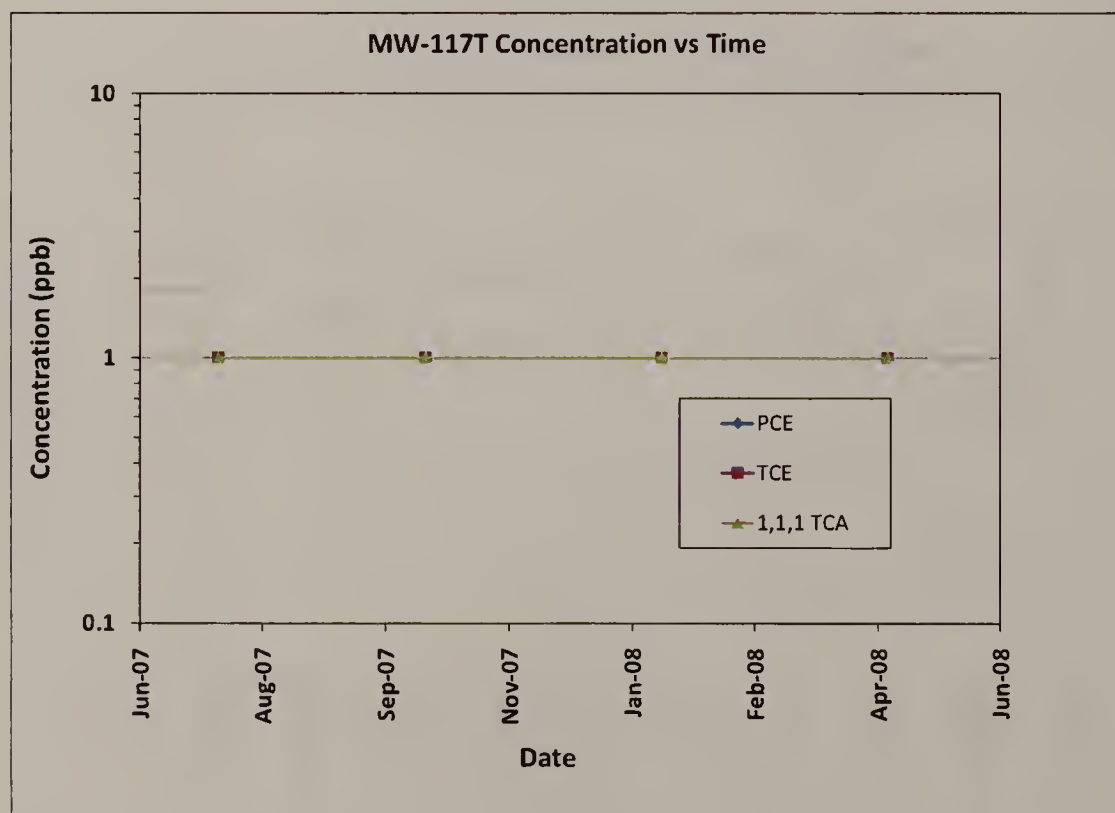
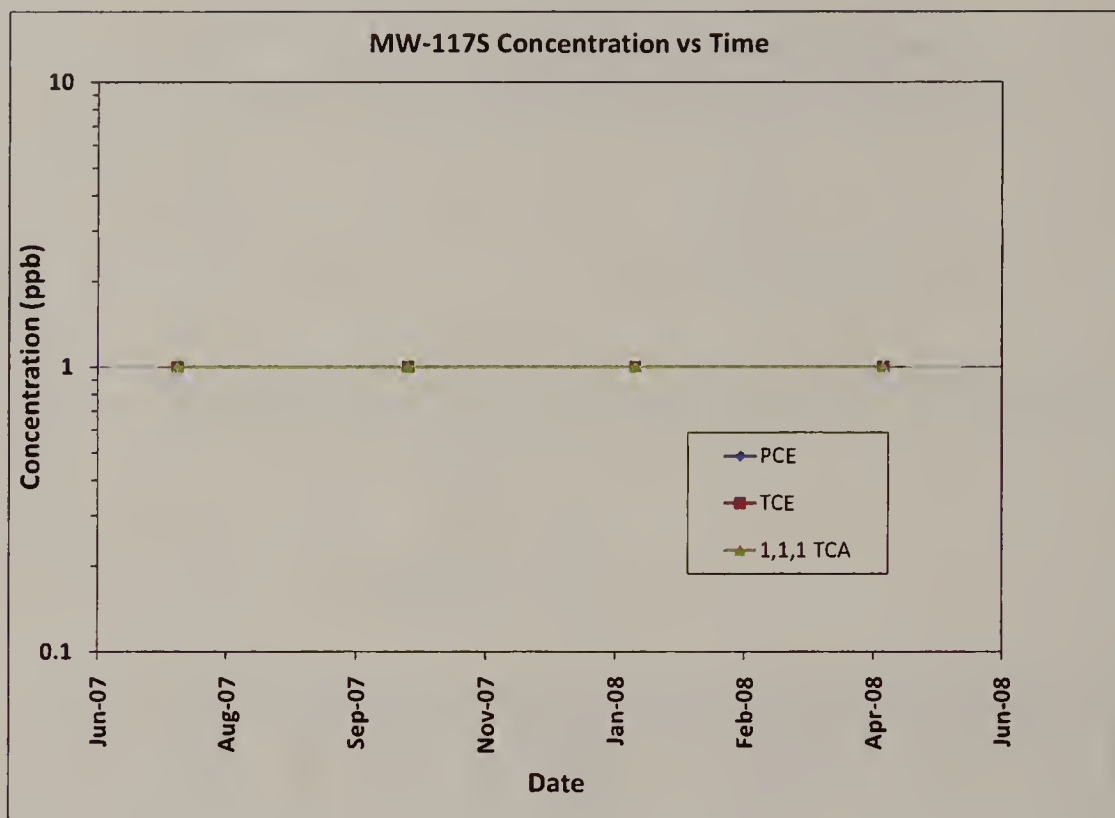


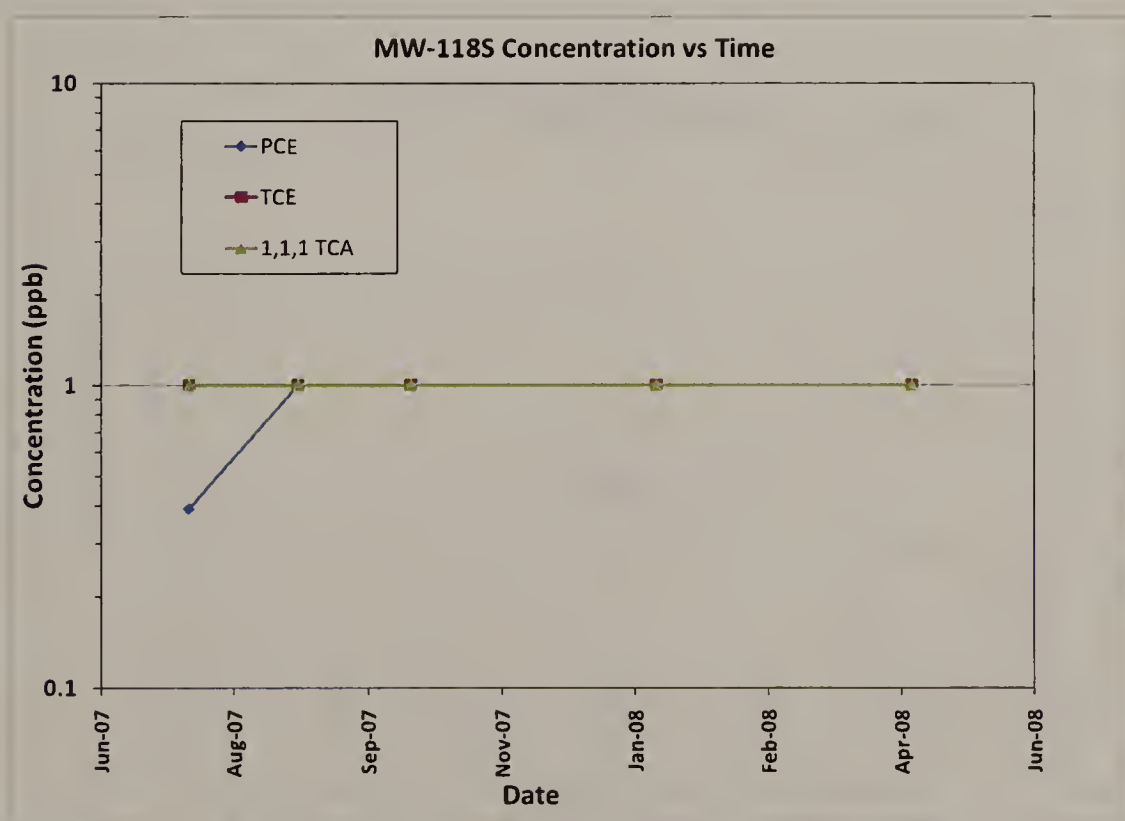
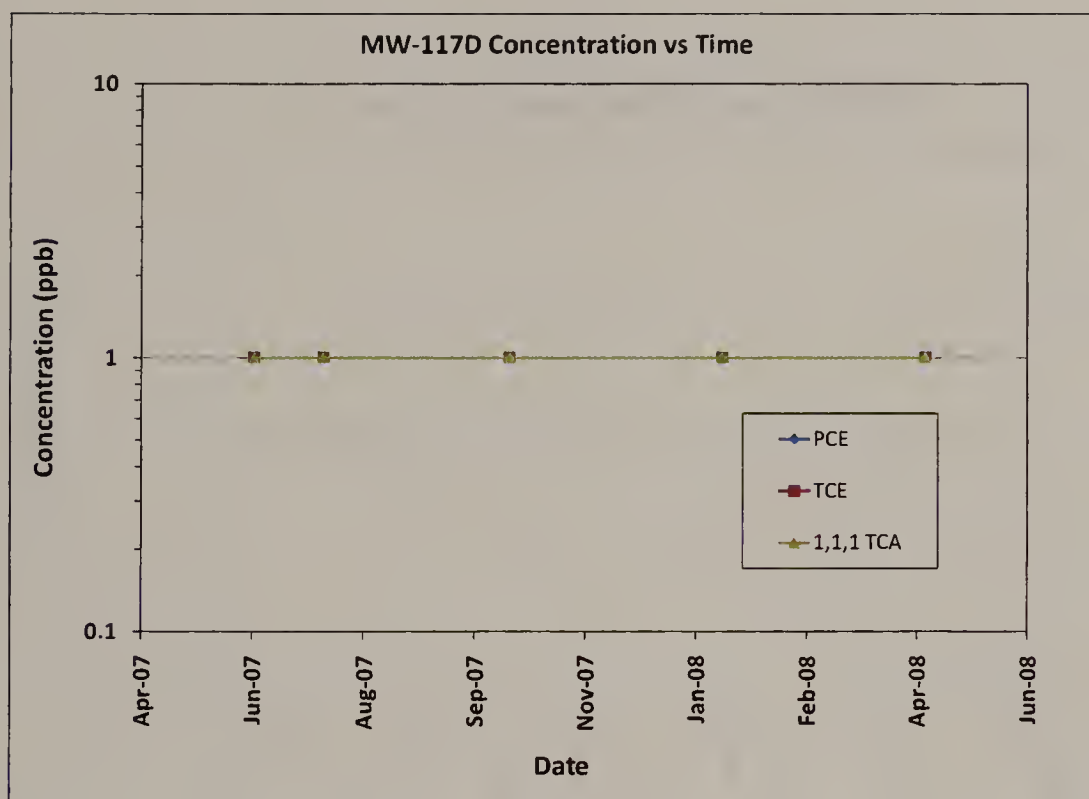


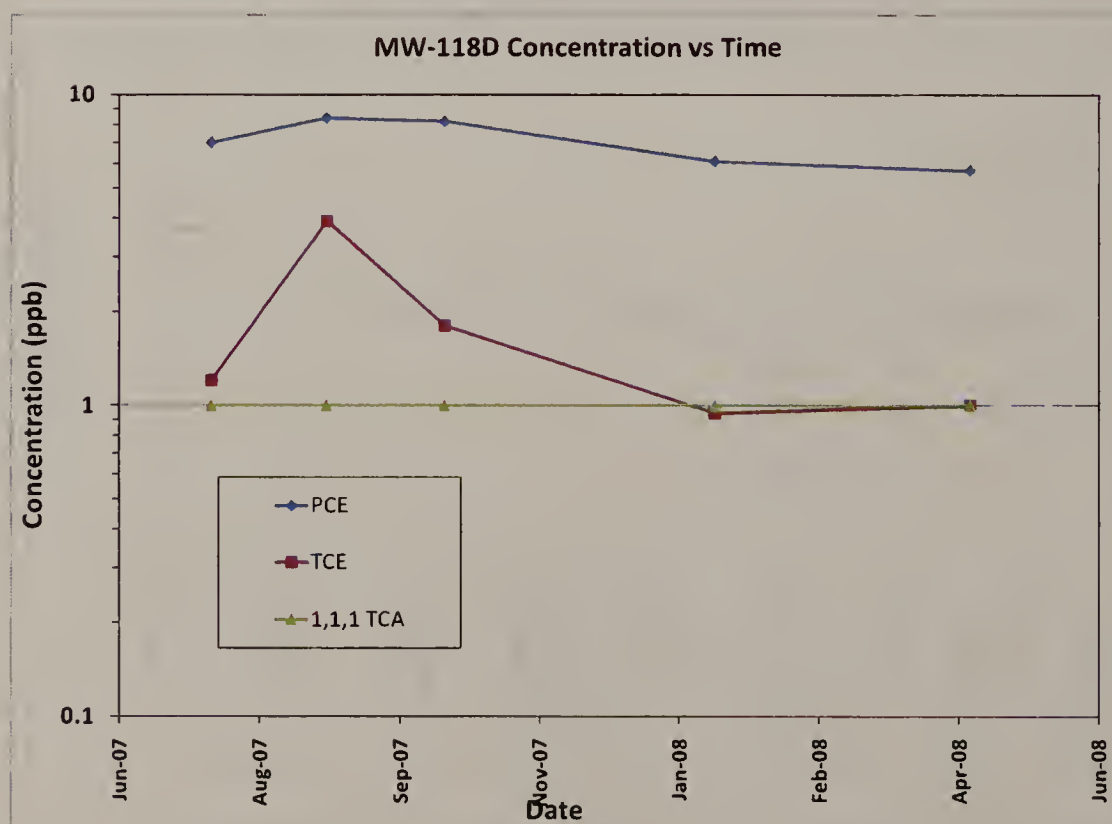
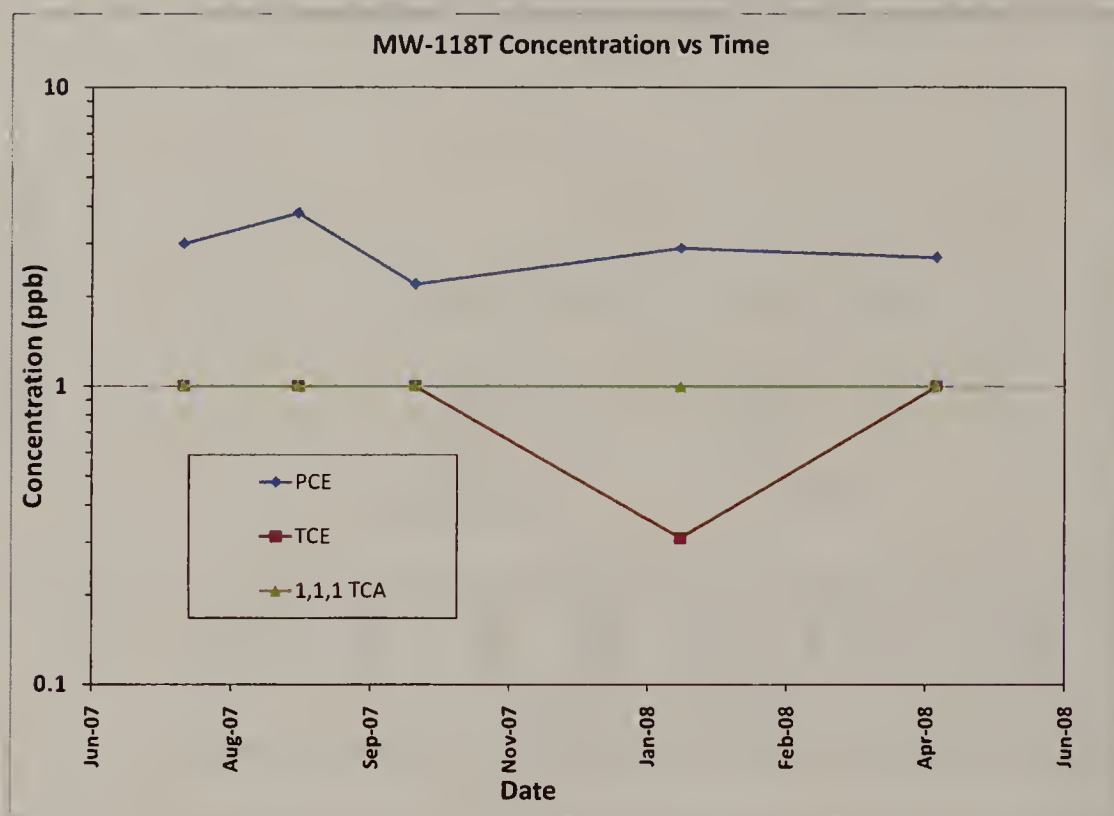


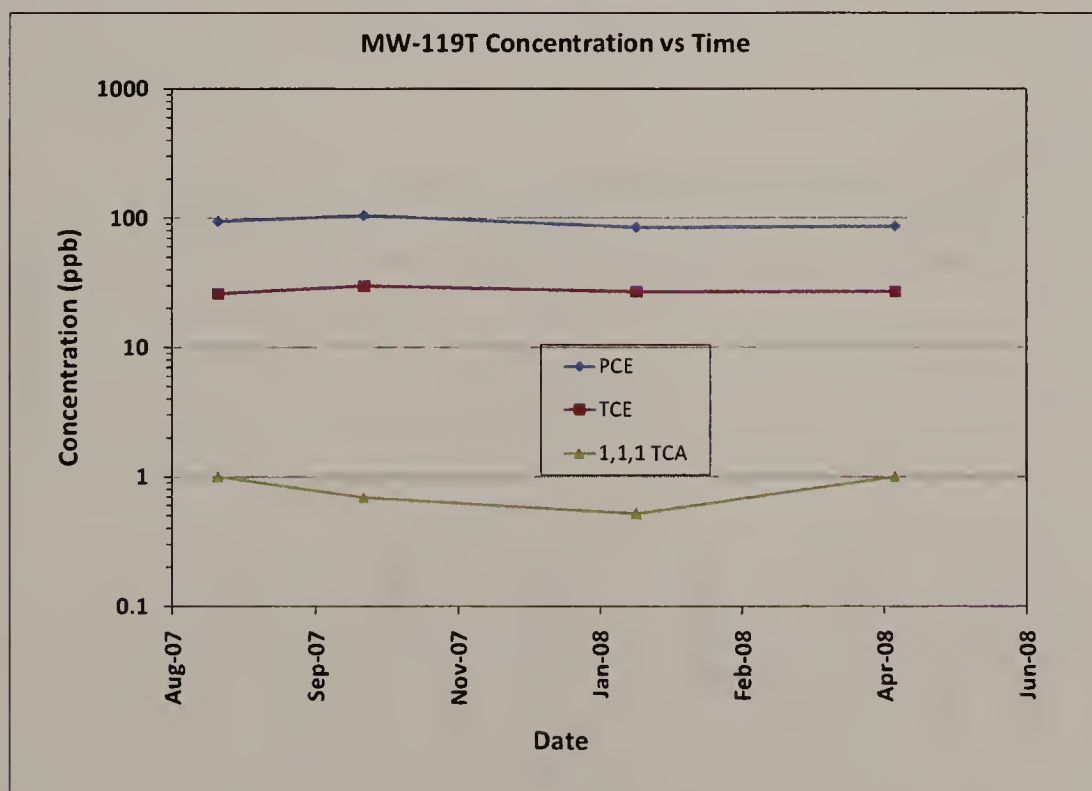
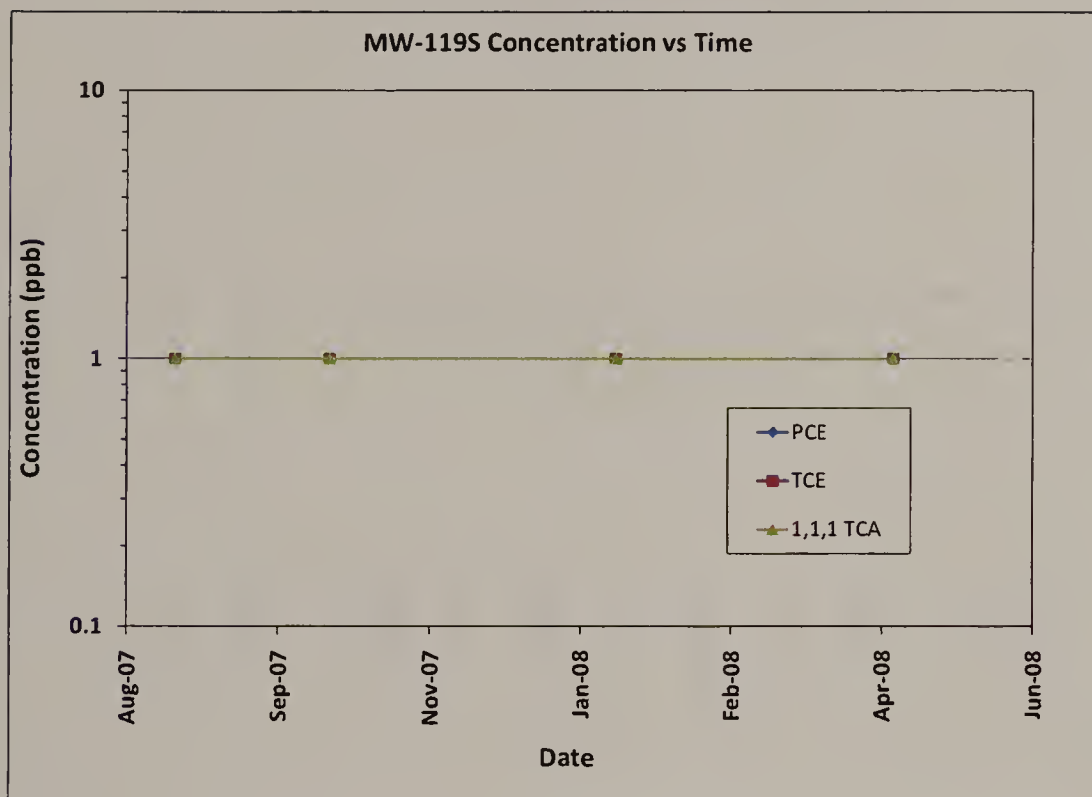


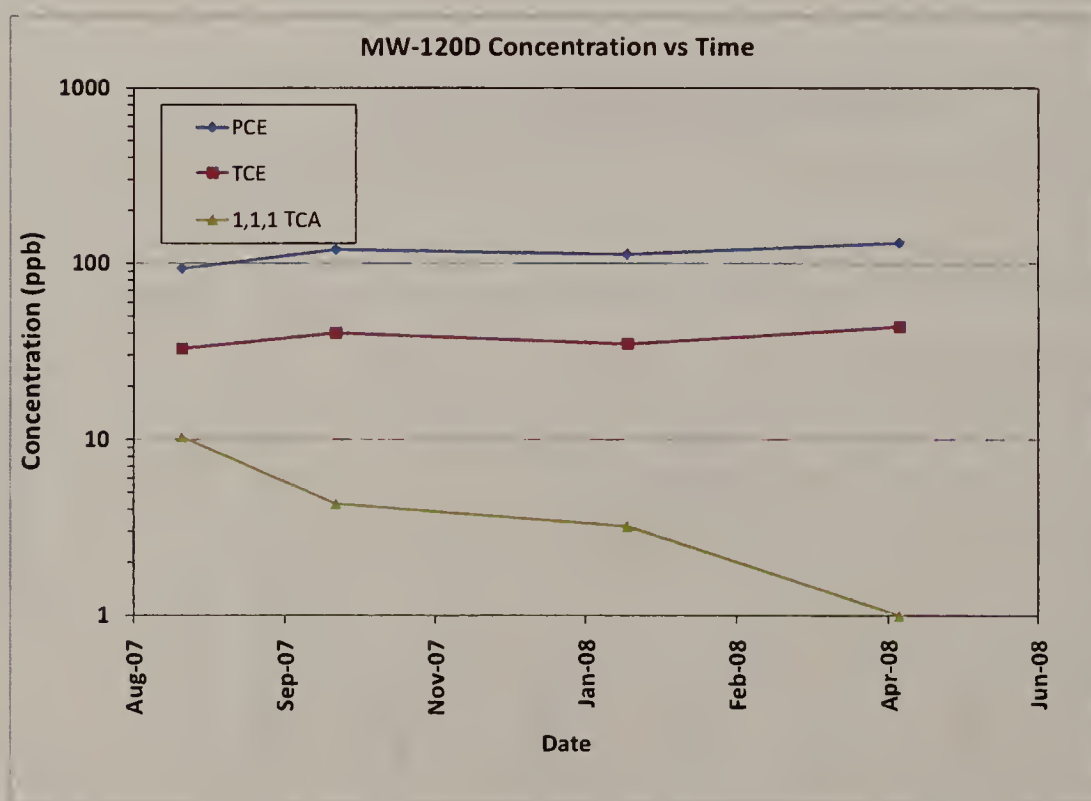
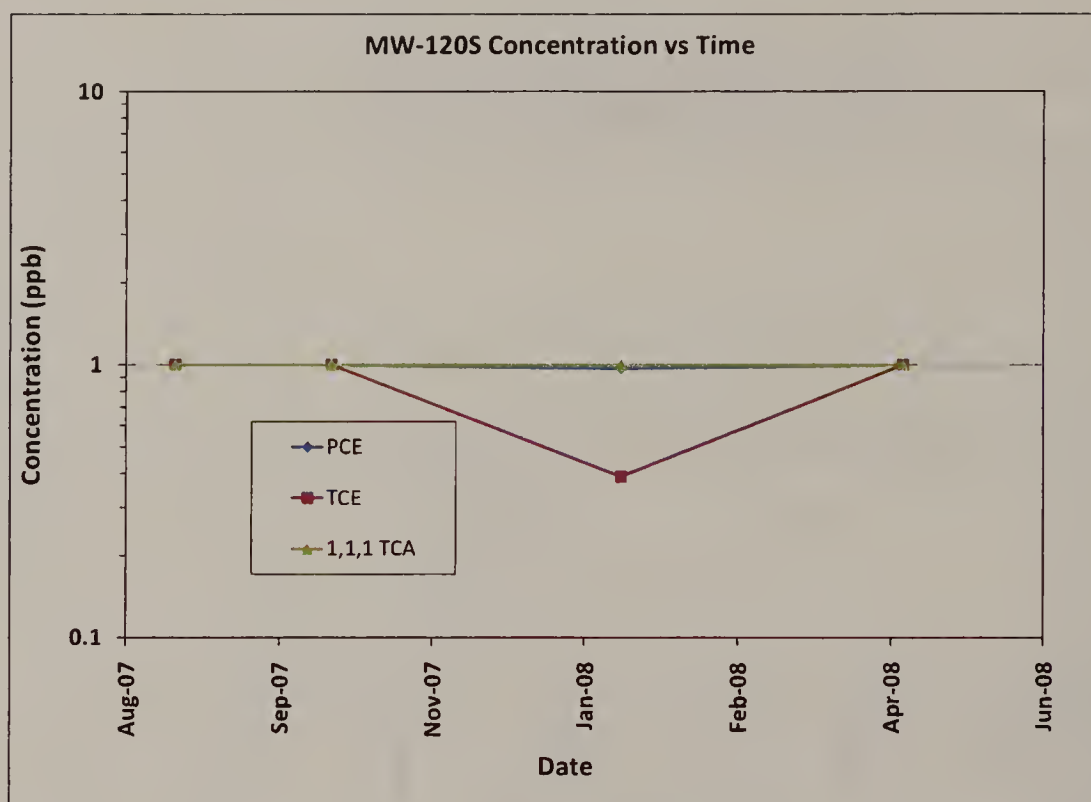


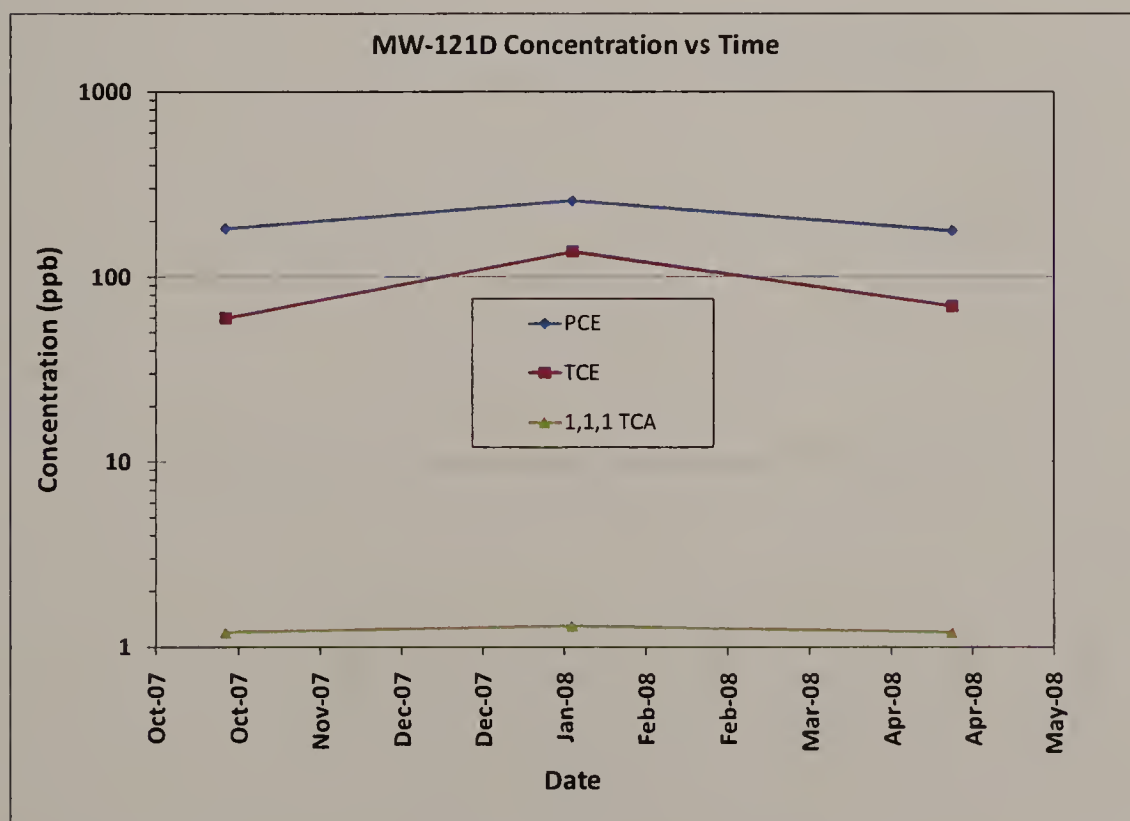
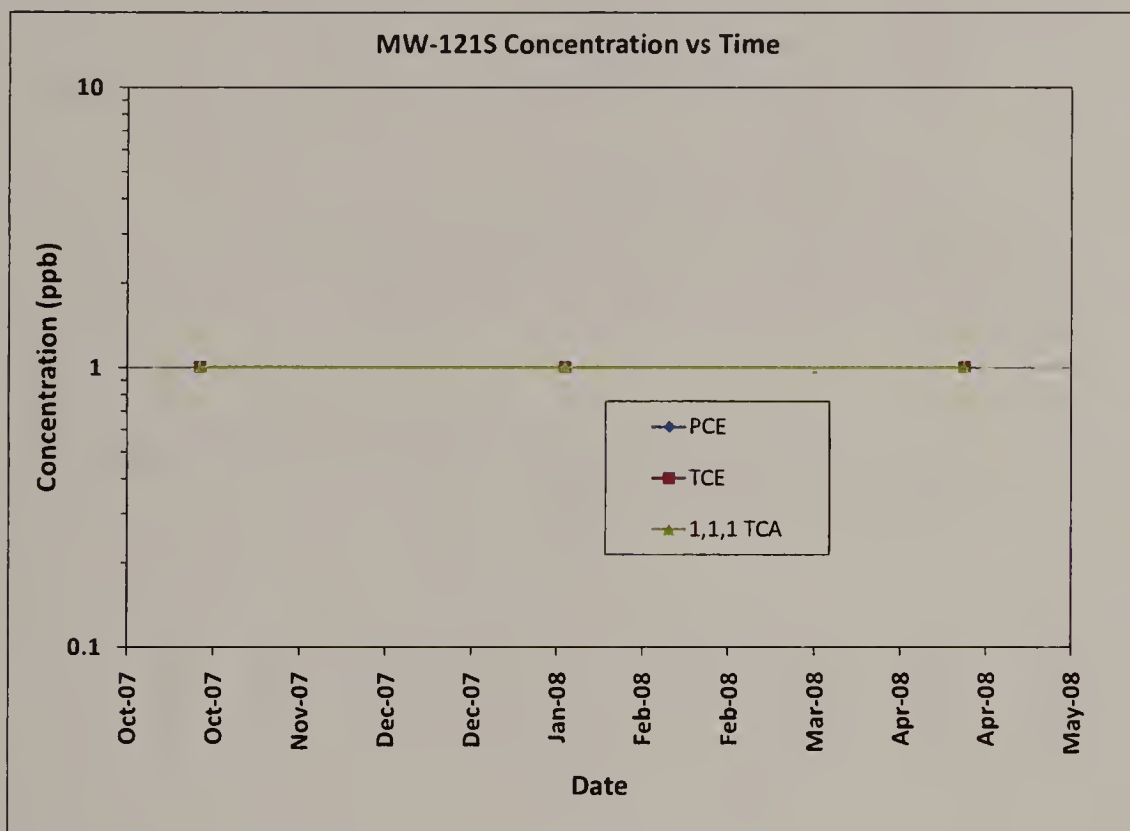


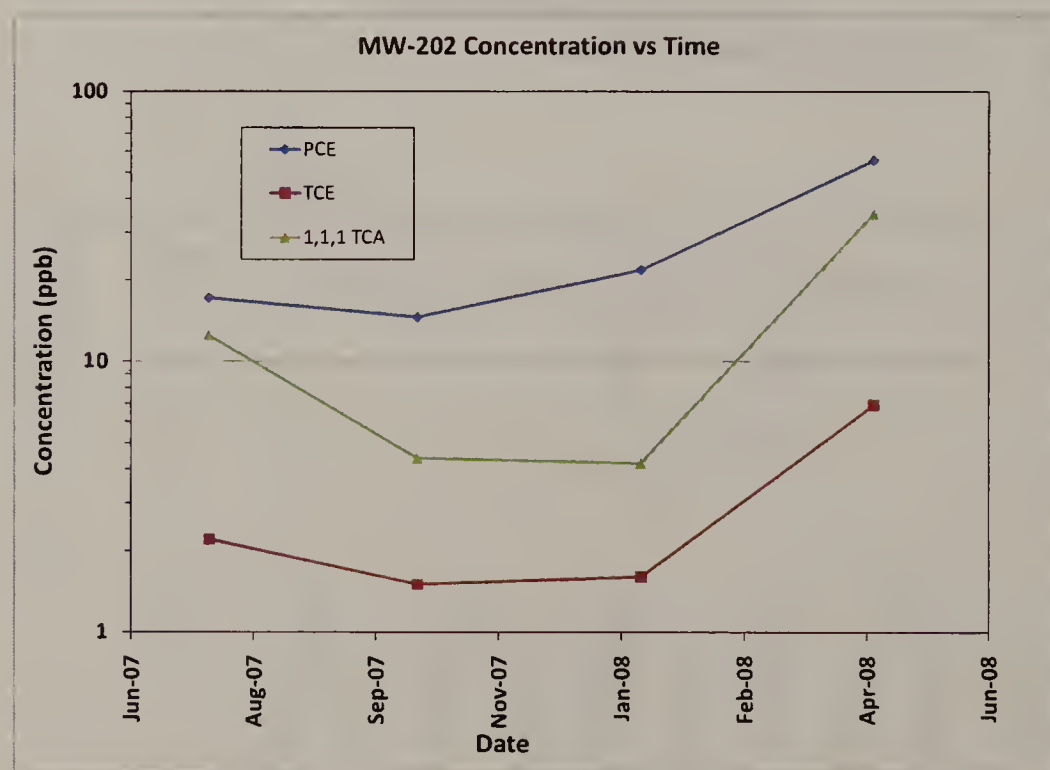
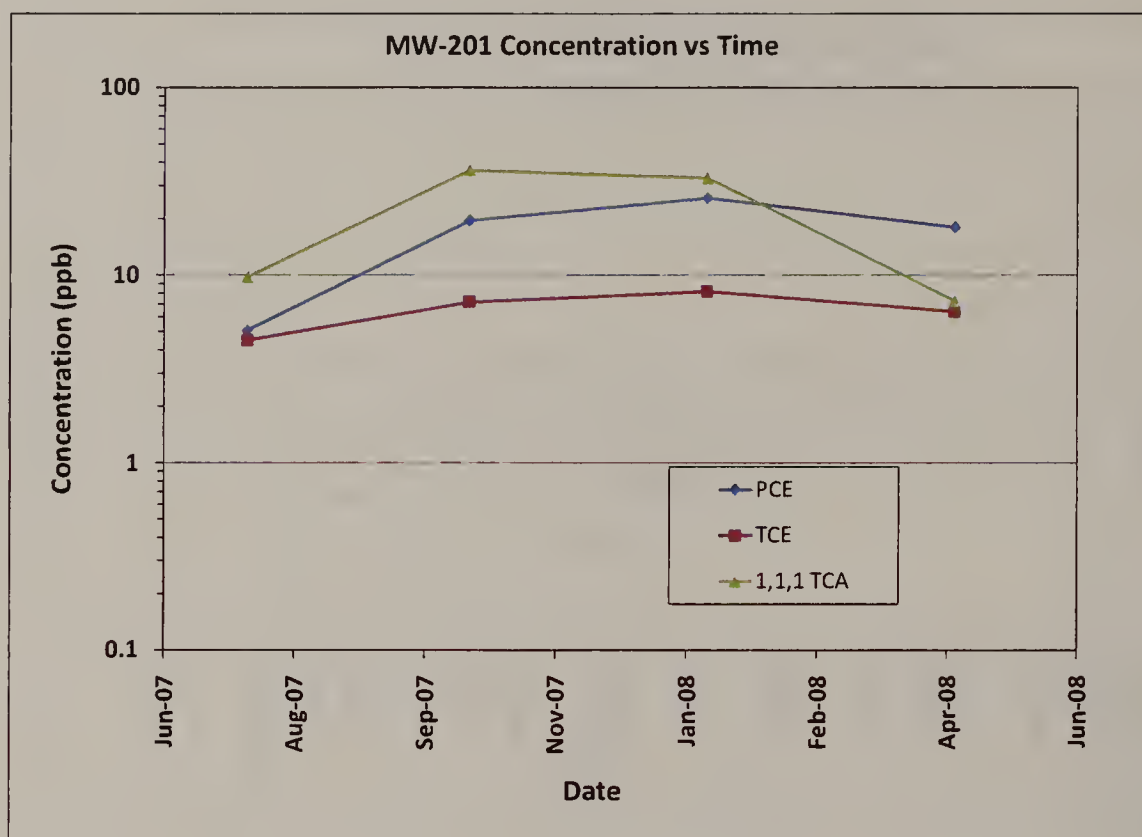


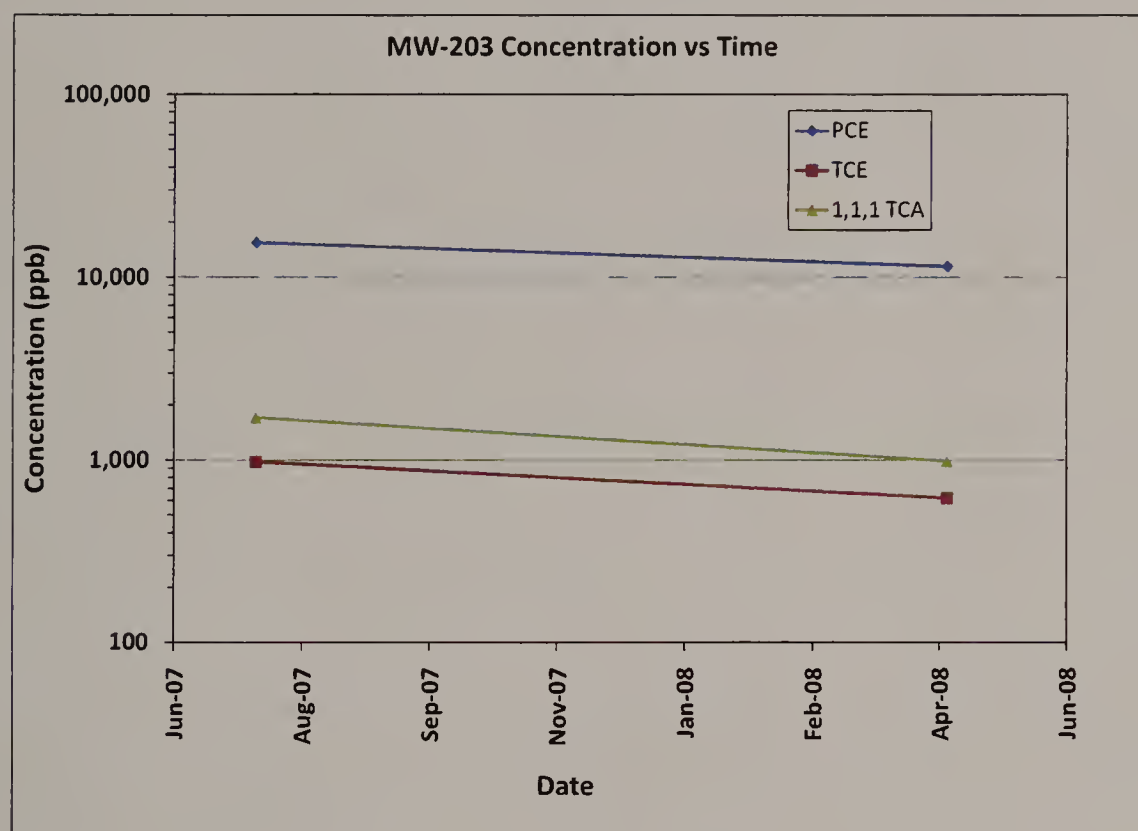






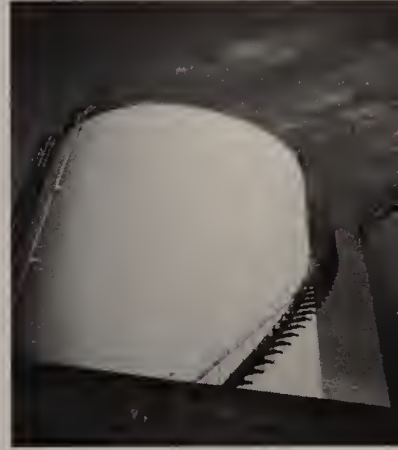








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Appendix I

GPR Survey Report



Geotechnical
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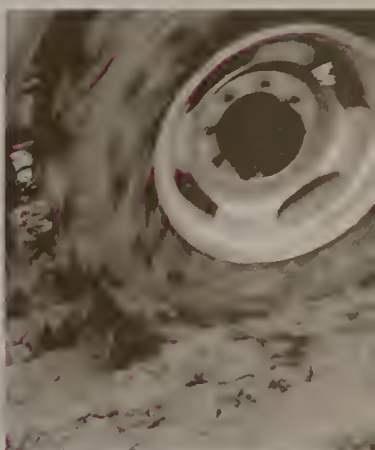
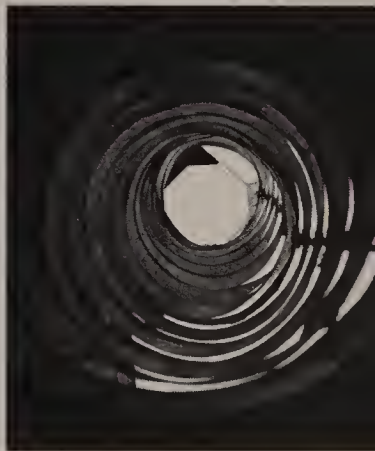


Appendix J

Laboratory Data Sheets – Shallow Soil Samples (Residential and Commercial Properties and 50 Tufts Street Property) and Samples Taken Between March 31 and May 9, 2008

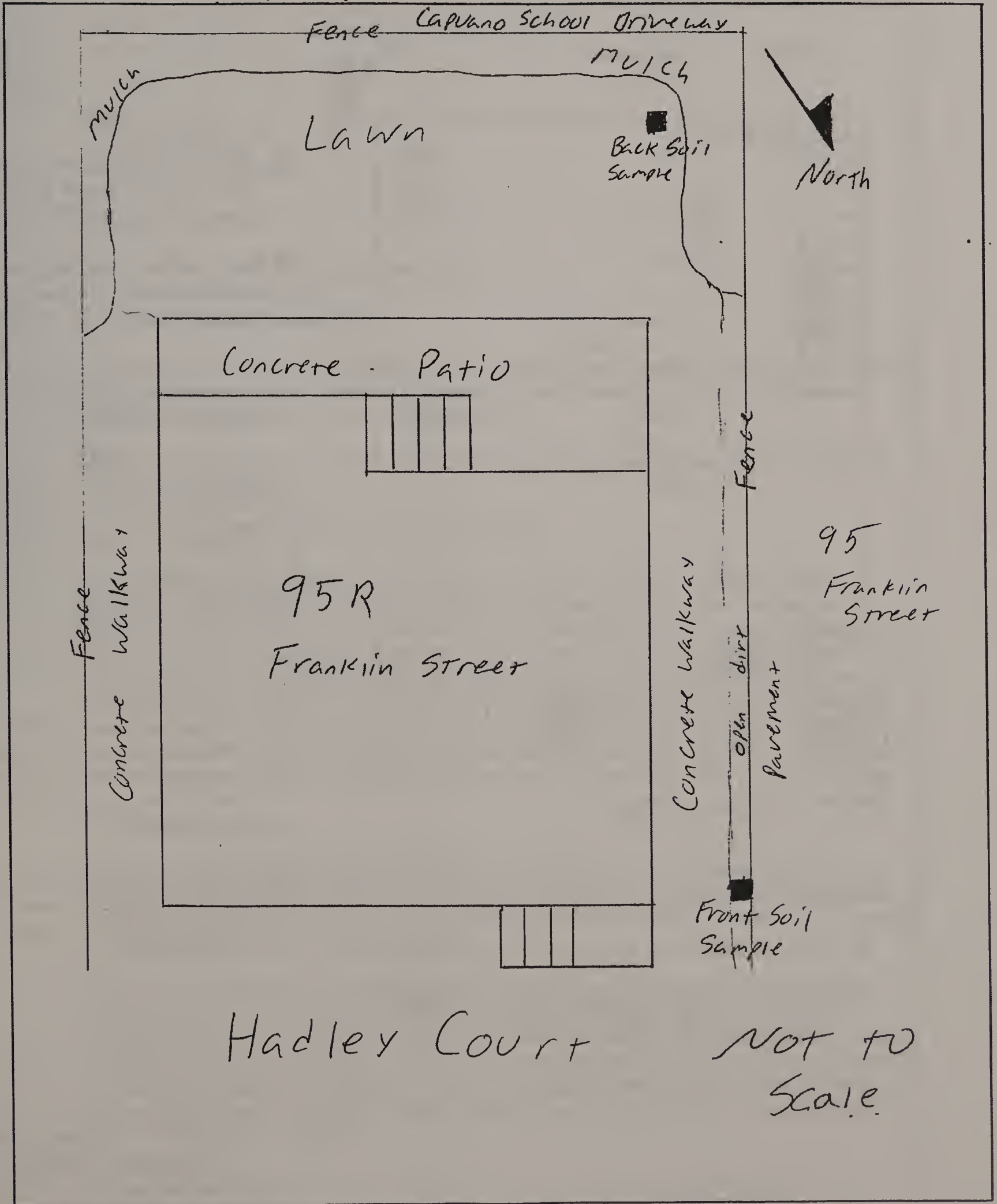


Geotechnical
Environmental and
Water Resources
Engineering



Appendix K

95R Franklin Street – Soil Sampling Locations and Site Specific Risk Assessment



Client Uni First Corporation

Date 1/18/08 By T. Daigle

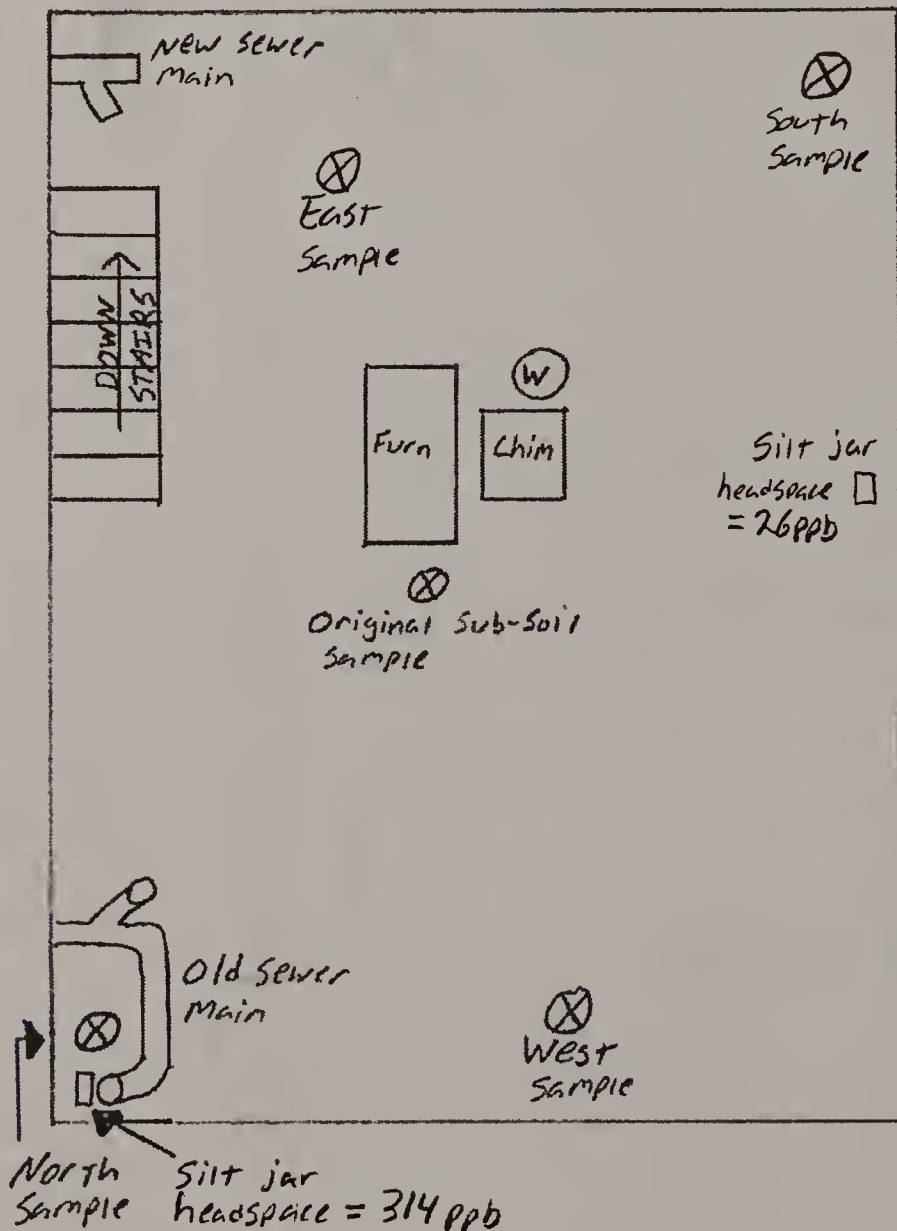
Subject 95R Franklin Street

Checked 1/24/08 By R. Simeon

Approved 2/1/08 By R. Simeon

Sub-Slab Soil Sample Locations

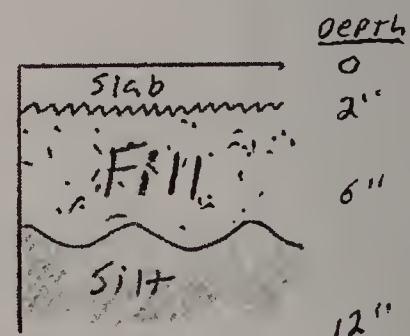
Hadley Court



⊗ North and South Samples were taken from the excavated trench

⊗ East, West, and Original Samples were taken through 6" core holes in the slab

Sub-Surface Typical Cross Section



Fill: Black Sand with silt. Abundant roots and charcoal. Includes bricks, some gravel, and miscellaneous metal fragments.

Silt: Tan to brown silt with sand dense, cohesive, contains brick fragments in some locations.

- NOT TO SCALE
- Features shown on this plan are approximate
- Jar headspace measured using PPB RAE calibrated to 10ppm isobutylene

Fig. 1 - 95R Franklin Street Basement SKETCH

February 15, 2008
Project 04516-2

Susan Southwick
95R Franklin Street
Somerville, MA 02145

Dear Ms. Southwick:

**Re: Soil and Indoor Air Sampling Results
95R Franklin Street
Somerville, Massachusetts**

On behalf of the UniFirst Corporation, GEI Consultants, Inc. conducted soil and indoor air testing at your home during the months of December 2007 and January 2008. We appreciate your cooperation in helping us to arrange this sampling.

We have attached summary tables of the results and the laboratory data sheets for the samples collected at your home.

Exposure Pathway Elimination Measure (EPEM)

In November and December 2007, GEI installed an Exposure Pathway Elimination Measure (EPEM) at 95R Franklin Street, which includes the original structure with a basement and an addition with a crawl space. The basement EPEM consisted of sealing the existing concrete floor in the basement, installing a vapor barrier system on the fieldstone (and brick) foundation walls, and installing a venting system beneath the vapor barrier. The crawl space EPEM consists of a venting layer and vapor barrier. As part of the EPEM installation, GEI collected soil samples from beneath the basement slab to characterize the soil removed from beneath your home for off-site disposal. Additional soil samples were collected from outside the footprint of your house. Following the installation of the EPEM, GEI collected indoor air samples.

Soil Testing Results

Nine soil samples were collected from beneath the basement slab on December 5, 11, and 14, 2007. A sketch showing sampling locations beneath the basement slab is Figure 1. Six additional soil samples were collected from outside the house footprint on January 8 and 9, 2008. A sketch showing the sampling locations is Figure 2.

Most of the soil samples from beneath the basement slab were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), extractable petroleum hydrocarbons (EPH), polychlorinated biphenyls (PCBs), total metals, total organic carbon (TOC), reactive cyanide, reactive sulfide, pH, specific conductivity, ignitibility, and percent solids. Three samples from beneath the basement slab and the samples collected outside the building footprint were analyzed for VOCs and TOC only.

Volatile Organic Compounds (VOCs) in Soil

Tetrachloroethylene (PCE) was detected in soil samples collected from beneath the basement slab at concentrations ranging from less than laboratory reporting limits to 58.9 mg/kg.

Trichloroethylene (TCE) was detected in soil samples collected from beneath the basement slab at concentrations ranging from less than laboratory reporting limits to 6.17 mg/kg, and cis-1,2 dichloroethane was detected at concentrations ranging from less than laboratory reporting limits to 0.772 mg/kg. Chlorinated VOCs were not detected at concentrations above laboratory reporting limits in soil samples collected from outside the building footprint. The soil testing results are summarized in Table 1 and laboratory data sheets are in Attachment A.

AMEC Earth and Environmental, Inc. conducted a site-specific risk assessment to evaluate potential health risks posed by the contaminants associated with the 50 Tufts Street disposal site (PCE, TCE and cis-1,2 dichloroethane). Based on the site specific risk assessment, the VOCs do not pose a significant health risk for any current or future use, including residential use. The site specific risk assessment is in Attachment B.

Metals and Polyaromatic Hydrocarbons (PAHs) in Soil

Lead, arsenic and several PAHs were detected at concentrations above the applicable reportable concentration (RCS1) in the Massachusetts Contingency Plan (MCP). The lead, arsenic, and PAHs are associated with the fill beneath the basement slab and are unrelated to the 50 Tufts Street disposal site.

It is GEI's opinion that the lead detected in the soil samples are related to paint chips observed in the soil and are exempt from notification in accordance with the MCP, 310 CMR 40.0317(8). In addition, it is GEI's opinion that the arsenic and PAHs detected in the soil samples are related to ash, coal ash, or wood ash, and are also exempt from notification in accordance with the MCP, 310 CMR 40.0317(9). The memorandum in Attachment C describes the reporting exemption.

Although the soil is exempt from notification under the MCP, it must be managed in a manner consistent with the MCP. Soils excavated for off-site disposal must be chemically characterized and disposed at an appropriate facility under the oversight of an environmental professional or Licensed Site Professional (LSP). The soil excavated from your property was disposed of appropriately.

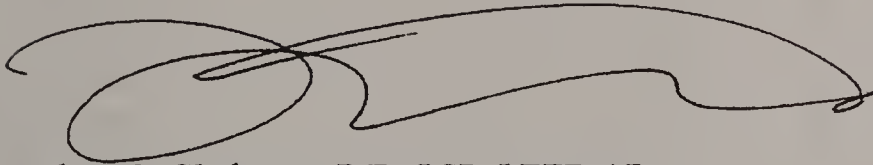
Indoor Air Testing Results

Following the completion of the EPEM installation, GEI collected indoor air samples on December 23 and 28, 2007. The indoor air testing results are summarized in Table 2 and laboratory data sheets are in Attachment D. The laboratory testing did not detect PCE or other chlorinated VOCs at a concentration above the laboratory reporting limits.

We appreciate your cooperation throughout the sampling process. If you have any immediate questions regarding the soil or indoor air testing results please do not hesitate to contact me at 781-721-4012 or at igladstone@geiconsultants.com.

Sincerely,

GEI CONSULTANTS, INC.

A handwritten signature in black ink, appearing to read 'Ileen S. Gladstone', with a large, stylized loop at the end.

Ileen S. Gladstone, P.E., LSP, LEED AP
Vice President

ISG:csH
Enclosures

c: John Badey, UniFirst Corporation
Peter Mills, City of Somerville
Irene Dale, Massachusetts Department of Environmental Protection

Table 1
Summary of Sub Slab Soil Testing Results
95R Franklin Street
Somerville, Massachusetts

				Sample ID: Date Sampled:	045162- 95RSUBSOIL 12/5/07	045162- 95RFRANK- EASTSILT 12/14/07	045162- 95RFRANK- EASTFILL 12/14/07	045162- 95RFRANK- WESTSILT 12/14/07	045162- 95RFRANK- WESTFILL 12/14/07	045162- 95RFRANK- NORTH SILT 12/11/2007	045162- 95RFRANK- NORTH FILL 12/11/2007	045162- 95RFRANK- SOUTH SILT 12/11/2007	045162- 95RFRANK- SOUTH FILL 12/11/2007	045162- 95RBACK Soil 1 1/8/2008	045162- 95RBACK Soil-0 3 1/8/2008	045162- 95RBACK Soil-5 7 1/8/2008	045162- 95RFRONT Soil 1 1/9/2008	045162- 95RFRONT Soil- 0-3 1/8/2008	045162- 95RFRONT Soil- 5-7 1/9/2008
Analyte	Method	Units	MCP Reportable Concentration																
			RCS-1 (mg/kg)																
Volatile Organic Compounds (VOCs)				SW846 8260B	mg/kg														
Benzene			2	< 0.053	< 0.049	< 0.051	< 0.039	< 0.060	< 0.042	< 0.047	< 0.041	0.156	NT	NT	NT	NT	NT	NT	NT
1,3-Dichlorobenzene			1	< 0.210	< 0.190	< 0.200	< 0.160	< 0.240	< 0.170	< 0.190	< 0.410	0.520	NT	NT	NT	NT	NT	NT	NT
1,4-Dichlorobenzene			0.7	< 0.210	< 0.190	< 0.200	< 0.160	< 0.240	< 0.170	< 0.190	0.0740 J	0.365	NT	NT	NT	NT	NT	NT	NT
1,1-Dichloroethane			0.4	0.107 J	< 0.190	0.430	< 0.160	< 0.240	< 0.170	< 0.190	< 0.170	< 0.260	NT	NT	NT	NT	NT	NT	NT
1,1-Dichloroethene			3	0.184 J	< 0.190	0.106 J	< 0.160	< 0.240	< 0.170	< 0.190	< 0.170	0.491	NT	NT	NT	NT	NT	NT	NT
cis-1,2-Dichloroethene			0.3	0.772	< 0.190	0.0969 J	< 0.160	0.132 J	< 0.170	< 0.190	< 0.170	0.674	NT	NT	NT	NT	NT	NT	NT
Ethylbenzene			40	< 0.210	< 0.190	< 0.200	< 0.160	< 0.240	< 0.170	< 0.190	< 0.170	0.0960 J	NT	NT	NT	NT	NT	NT	NT
Methylene chloride			0.1	< 0.210	< 0.190	< 0.200	< 0.160	< 0.240	0.0818 JB	< 0.190	0.0827 J	0.205 JB	NT	NT	NT	NT	NT	NT	NT
Naphthalene			4	< 0.530	< 0.490	< 0.510	< 0.390	< 0.600	< 0.420	< 0.470	< 0.410	0.198 J	NT	NT	NT	NT	NT	NT	NT
Tetrachloroethene			1	42.1	3.34	46.2	< 0.160	5.64	< 0.170	1.14	0.0381 J	58.9	< 0.160	< 0.160	< 0.180	< 0.130	< 0.120	< 0.250	< 0.250
Toluene			30	0.0558 J	< 0.490	< 0.510	< 0.390	< 0.600	< 0.420	< 0.470	< 0.410	0.264 J	NT	NT	NT	NT	NT	NT	NT
1,1,1,-Trichloroethane			30	0.0604 J	< 0.190	0.0476 J	< 0.160	< 0.240	< 0.170	< 0.190	< 0.170	< 0.260	< 0.160	< 0.160	< 0.180	< 0.130	< 0.120	< 0.250	< 0.250
Trichloroethene			0.3	3.31	0.319	2.16	< 0.160	0.660	< 0.170	0.268	< 0.170	6.17	< 0.160	< 0.160	< 0.180	< 0.130	< 0.120	< 0.250	< 0.250
1,2,4-Trimethylbenzene			1000	< 0.530	< 0.490	< 0.510	< 0.390	< 0.600	< 0.420	< 0.470	< 0.420	0.268 J	NT	NT	NT	NT	NT	NT	NT
m,p-Xylene			300	< 0.210	< 0.190	< 0.200	< 0.160	< 0.240	< 0.170	< 0.190	< 0.170	0.575	NT	NT	NT	NT	NT	NT	NT
o-Xylene			300	< 0.210	< 0.190	< 0.200	< 0.160	< 0.240	< 0.170	< 0.190	< 0.170	0.141 J	NT	NT	NT	NT	NT	NT	NT
Total VOCs				47	3.66	49.0	ND	6.43	0.0818	1.41	0.195	69.0							
Semivolatile Organic Compounds (SVOCs)				SW846 8270C	mg/kg														
2-Methylphenol			500	NT	< 0.560	< 0.590	< 0.590	0.0633 J	NT	< 0.630	NT	NT	NT	NT	NT	NT	NT	NT	NT
3&4-Methylphenol			500	NT	< 0.560	< 0.590	< 0.590	0.148 J	NT	< 0.630	NT	NT	NT	NT	NT	NT	NT	NT	NT
Acenaphthene			4	NT	< 0.280	0.257 J	0.0308 J	0.0563 J	NT	< 0.310	NT	NT	NT	NT	NT	NT	NT	NT	NT
Acenaphthylene			1	NT	0.0592 J	0.636	0.368	0.264 J	NT	0.0571 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
Anthracene			1000	NT	0.103 J	0.764	0.0398 J	0.136 J	NT	0.153 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(a)anthracene			7	NT	0.245 J	1.65	0.0526 J	0.327	NT	0.504	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(a)pyrene			2	NT	0.283	1.73	< 0.290	0.305 J	NT	0.514	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(b)fluoranthene			7	NT	0.617	1.79	< 0.290	0.671	NT	0.814	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(g,h,i)perylene			1000	NT	0.384	0.876	< 0.290	0.363	NT	0.575	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(k)fluoranthene			70	NT	0.290	1.44	< 0.290	0.301 J	NT	0.464	NT	NT	NT	NT	NT	NT	NT	NT	NT
Bis(2-ethylhexyl)phthalate			100	NT	0.225 J	< 0.300	0.194 J	0.208 J	NT	< 0.310	NT	NT	NT	NT	NT	NT	NT	NT	NT
Chrysene			70	NT	0.274 J	1.84	0.0468 J	0.323	NT	0.509	NT	NT	NT	NT	NT	NT	NT	NT	NT
Dibenz(a,h)anthracene			0.7	NT	0.230 J	0.479	< 0.290	0.292 J	NT	0.271 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
Dibenzofuran			100	NT	0.0388 J	0.424	0.187 J	0.151 J	NT	< 0.310	NT	NT	NT	NT	NT	NT	NT	NT	NT
Di-n-butyl phthalate			50	NT	< 0.280	0.0801 J	< 0.290	< 0.310	NT	< 0.310	NT	NT	NT	NT	NT	NT	NT	NT	NT
Fluoranthene			1000	NT	0.622	3.64	0.135 J	0.808	NT	1.1	NT	NT	NT	NT	NT	NT	NT	NT	NT
Fluorene			1000	NT	< 0.280	0.45	0.167 J	0.145 J	NT	0.0379 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
Indeno(1,2,3-cd)pyrene			7	NT	0.361	1.07	< 0.290	0.35	NT	0.518	NT	NT	NT	NT	NT	NT	NT	NT	NT
2-Methylnaphthalene			4	NT	0.0888 J	1.18	0.755	0.553	NT	< 0.310	NT	NT	NT	NT	NT	NT	NT	NT	NT
Naphthalene			4	NT	0.612	5.30	5.13	3.60	NT	0.0638 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
Phenanthrene			10	NT	0.469	3.02	0.220 J	0.620	NT	0.663	NT	NT	NT	NT	NT	NT	NT	NT	NT
Pyrene			1000	NT	0.469	2.77	0.0932 J	0.602	NT	0.939	NT	NT	NT	NT	NT	NT	NT	NT	NT
Total SVOCs				NT	5.37	29.4	7.42	10.3	NT	7.18	NT	NT	NT	NT	NT	NT	NT	NT	NT
Extractable Petroleum Hydrocarbons (EPH)				MADEP EPH REV 1.1	mg/kg														
C9-C18 Aliphatics			1000	< 12.0	9.940 J	31.3	9.56 J	< 12.0	NT	< 12.0	NT	NT	NT	NT	NT	NT	NT	NT	NT
C19-C36 Aliphatics			3000	28.9	< 11.0	52.3	< 11.0	20.2	NT	< 12.0	NT	NT	NT	NT	NT	NT	NT	NT	NT
C11-C22 Aromatics			1000	171	20.5 J	123	< 22.0	< 24.0	NT	< 25.0	NT	NT	NT	NT	NT	NT	NT	NT	NT
Total EPH			NS	200	30.4	207	9.56	20.2	NT	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT
Polycyclic Aromatic Hydrocarbons (PAHs)				MADEP EPH REV 1.1	mg/kg														
Acenaphthene			4	1.08	< 0.540	< 0.560	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Anthracene			1000	2.31	< 0.540	0.669	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(a)anthracene			7	5.21	< 0.540	1.25	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(a)pyrene			2	6.25	< 0.540	2.08	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(b)fluoranthene			7	6.03	< 0.540	2.06	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(g,h,i)perylene			1000	3.64	0.630	2.45	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Benzo(k)fluoranthene			70	4.60	< 0.540	1.74	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Chrysene			70	6.73	< 0.540	1.68	< 0.550	< 0.600	NT	0.527 J	NT	NT	NT	NT	NT	NT	NT	NT	NT
Dibenz(a,h)anthracene			0.7	0.959	< 0.540	0.460 J	< 0.550	< 0.600	NT	< 0.620	NT	NT	NT	NT	NT	NT	NT	NT	NT
Fluoranthene			1000	12.6	0.442 J	3.12	< 0.550	0.580 J	NT	0.837	NT	NT	NT	NT	NT	NT	NT	NT	NT
Fluorene			1000	1.63	< 0.540	< 0.560</													

Table 1
Summary of Sub Slab Soil Testing Results
95R Franklin Street
Somerville, Massachusetts

Sample ID: Date Sampled:				045162- 95RSUBSOIL 12/5/07	045162- 95RFRANK- EASTSILT 12/14/07	045162- 95RFRANK- EASTFILL 12/14/07	045162- 95RFRANK- WESTSILT 12/14/07	045162- 95RFRANK- WESTFILL 12/14/07	045162- 95RFRANK- NORTH SILT 12/11/2007	045162- 95RFRANK- NORTH FILL 12/11/2007	045162- 95RFRANK- SOUTH SILT 12/11/2007	045162- 95RFRANK- SOUTH FILL 12/11/2007	045162- 95RBACK Soil 1 1/8/2008	045162- 95RBACK Soil-0 3 1/8/2008	045162- 95RBACK Soil-5 7 1/8/2008	045162- 95RFRONT Soil 1 1/9/2008	045162- 95RFRONT Soil- 0-3 1/8/2008	045162- 95RFRONT Soil- 5-7 1/9/2008
Analyte	Method	Units	MCP Reportable Concentration RCS-1 (mg/kg)															
Polychlorinated Biphenyls (PCBs) Total PCBs	SW846 8082	mg/kg	2	ND	ND	ND	ND	ND	NT	ND	NT	NT	NT	NT	NT	NT	NT	NT
Metals	SW846 6010B	mg/kg																
Arsenic			20	36.4	10.9	31.5	12.6	19.2	NT	19.3	NT	NT	NT	NT	NT	NT	NT	NT
Barium			1000	517	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Cadmium			2	1.8	< 0.46	1.5	< 0.44	< 0.47	NT	0.53	NT	NT	NT	NT	NT	NT	NT	NT
Chromium			1000	25	22.8	25.1	32	23.2	NT	17	NT	NT	NT	NT	NT	NT	NT	NT
Lead			300	3580	499	4870	44.2	874	NT	1890	NT	NT	NT	NT	NT	NT	NT	NT
Silver			100	1.2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Selenium			400	4.1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Mercury	SW846 7471A	mg/kg	20	5.2	0.26	3.0	0.039	0.71	NT	0.79	NT	NT	NT	NT	NT	NT	NT	NT
TCLP		mg/L																
Textrachloroethene	SW846 1311/8260		0.70	0.0418 J	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Lead	SW846 1311		5.0	2.0	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Physical/Inorganic																		
Cyanide Reactivity	SW846 CHAP7	mg/kg	NS	<1.8	<1.8	<1.9	<1.8	<1.9	NT	<1.9	NT	NT	NT	NT	NT	NT	NT	NT
Ignitibility	SW846 1020	deg F	NS	>230	>230	>230	>230	>230	NT	>230	NT	NT	NT	NT	NT	NT	NT	NT
pH	SW846 9045	pH units	NS	NT	6.5	8.7	8	9.8	NT	7.7	NT	NT	NT	NT	NT	NT	NT	NT
Specific Conductivity	EPA 120.1 M	umhos/cm	NS	401	1220	2770	188	361	NT	382	NT	NT	NT	NT	NT	NT	NT	NT
Solids, Percent	EPA 160.3 M	%	NS	81.1	85.4	81.0	84.1	80.3	82.2	78.5	82.1	83.3	79.5	79.5	80.7	82	82	77.7
Sulfide Reactivity	SW846 CHAP7	mg/kg	NS	<62	<59	<62	<59	<62	NT	<64	NT	NT	NT	NT	NT	NT	NT	NT
Total Organic Carbon	SW846 9060M	mg/kg	NS	203000	20300	219000	17100	159000	5730	84000	1560	351000	NT	53000	< 1200	NT	29800	6020

- General Notes**
- 1 The laboratory analyses were performed by Accutest Laboratories.
 - 2 In general, only analytes detected in at least one sample are reported here. For a complete list of analytes see the laboratory data sheets.
 - 3 < = Analyte not detected at a concentration above the specified laboratory reporting limit.
 - 4 Reportable Concentrations (e.g. RCS-1), where identified, are cited from the MCP.
 - 5 MCP = 310 CMR 40.0000 Massachusetts Contingency Plan, updated February 14, 2008.
 - 6 mg/kg = milligrams per kilogram.
 - 7 ND = Not detected above laboratory reporting limit. See the laboratory data reports for the detection limits.
 - 8 NS = No known standard for this analyte.
 - 9 umhos/cm = micromhos per centimeter.
 - 10 Unlined landfill disposal criteria are from the Massachusetts Department of Environmental Protection's Policy #COMM-97-001, dated August 15, 1997.
 - 11 NT = Not tested.
 - 12 Concentrations in bold exceed the given standard.

Qualifying Notes

J The reported result is below the laboratory reporting limit and is estimated.

Table 2
Testing Results- Indoor Air Samples
95R Franklin Street
Somerville, MA

Sample Location: Sample Name: Sample Date: Collected by:		95R Franklin Street									
		045162-95R Fran-1 4/18/07 GEI		045162-95R Fran-B 4/18/07 GEI		045162-95RFRANK-1 6/5/07 GEI		045162-95RFRANK-CR 6/5/07 GEI		045162-95RFRANK-1 8/23/2007 GEI	
		µg/m ³	ppbv	µg/m ³	ppbv	µg/m ³	ppbv	µg/m ³	ppbv	µg/m ³	ppbv
Analyte	Units:										
Volatile Organic Compounds (VOCs)											
Carbon tetrachloride		0.75 J	0.12 J	< 1.3	< 0.20	0.88 J	0.14 J	< 6.3	< 1.0	0.69 J	0.11 J
1,1,1-Trichloroethane		< 1.1	< 0.20	0.98 J	0.18 J	< 1.1	< 0.20	< 1.1	< 0.20	< 1.1	< 0.20
Tetrachloroethylene (PCE)		35	5.1	106	15.6	19	2.8	8.1	1.2	3.5	0.52
Trichloroethylene (TCE)		1.1	0.20	2.7	0.51	0.75 J	0.14 J	< 5.4	< 1.0	< 1.1	< 0.20

General Notes:

1. Analytes detected in at least one sample are reported here.
For a complete list of analytes see the laboratory data sheets.
2. "L" = The analyte was not detected at a concentration above the specified limit.
3. µg/m³ = micrograms per cubic meter.
4. ppbv = parts per billion by volume.

Qualifying Note:

J The reported result is below the laboratory reporting limit and is estimated.

Client Uni First Corporation

Date 1/18/08

By T. Daigle

Subject 95R Franklin Street

Checked 1/24/08

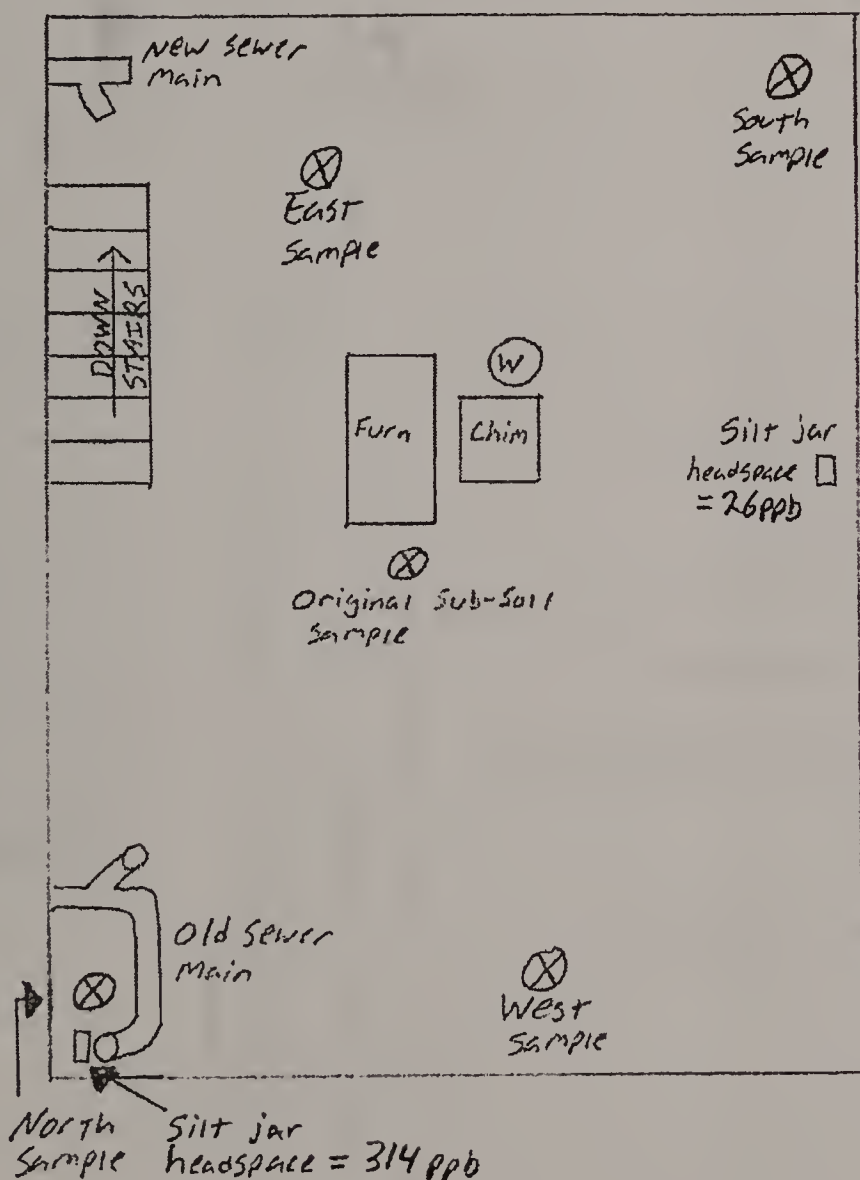
By R. Simon

Sub-Slab Soil Sample Locations

Approved 2/1/08

By R. Simon

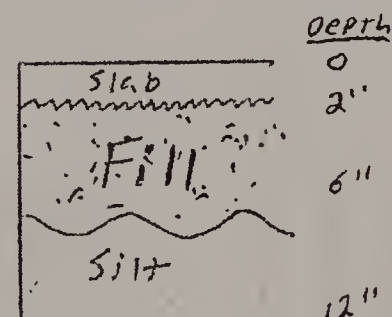
Hadley Court



⊗ North and South Samples were taken from the excavated trench

⊗ East, West, and Original Samples were taken Through 6" Core holes in The Slab

Sub-Surface Typical Cross Section



Fill: Black Sand with silt. Abundant roots and Charcoal. Includes bricks, some gravel, and miscellaneous metal fragments.

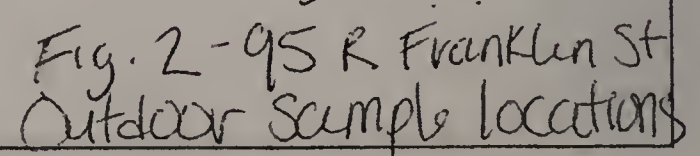
Silt: Tan to brown Silt with Sand dense, Cohesive, Contains brick fragments in some locations.

■ NOT TO SCALE

■ Features shown on This Plan are Approximate

■ Jar headspace measured using ppb RAE Calibrated to 10ppm isobutylene

Fig. 1 - 95R Franklin Street Basement SKETCH



Attachment A

Soil Sampling Laboratory Data Sheets

Report of Analysis

Page 1 of 3

3.1

Client Sample ID: 045162-95RSUBSOIL
 Lab Sample ID: M69502-1
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/05/07
 Date Received: 12/05/07
 Percent Solids: 81.1

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H43677.D	1	12/06/07	SC	n/a	n/a	MSH1354
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	6.52 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	530	350	ug/kg	
71-43-2	Benzene	ND	53	19	ug/kg	
108-86-1	Bromobenzene	ND	530	39	ug/kg	
74-97-5	Bromochloromethane	ND	530	100	ug/kg	
75-27-4	Bromodichloromethane	ND	210	20	ug/kg	
75-25-2	Bromoform	ND	210	40	ug/kg	
74-83-9	Bromomethane	ND	210	48	ug/kg	
78-93-3	2-Butanone (MEK)	ND	530	140	ug/kg	
104-51-8	n-Butylbenzene	ND	530	22	ug/kg	
135-98-8	sec-Butylbenzene	ND	530	15	ug/kg	
98-06-6	tert-Butylbenzene	ND	530	20	ug/kg	
75-15-0	Carbon disulfide	ND	530	52	ug/kg	
56-23-5	Carbon tetrachloride	ND	210	17	ug/kg	
108-90-7	Chlorobenzene	ND	210	17	ug/kg	
75-00-3	Chloroethane	ND	530	28	ug/kg	
67-66-3	Chloroform	ND	210	65	ug/kg	
74-87-3	Chloromethane	ND	530	32	ug/kg	
95-49-8	o-Chlorotoluene	ND	530	19	ug/kg	
106-43-4	p-Chlorotoluene	ND	530	36	ug/kg	
108-20-3	Di-Isopropyl ether	ND	210	14	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	530	180	ug/kg	
124-48-1	Dibromochloromethane	ND	210	30	ug/kg	
106-93-4	1,2-Dibromoethane	ND	210	28	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	210	18	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	210	38	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	210	46	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	530	13	ug/kg	
75-34-3	1,1-Dichloroethane	107	210	28	ug/kg	J
107-06-2	1,2-Dichloroethane	ND	210	14	ug/kg	
75-35-4	1,1-Dichloroethene	184	210	35	ug/kg	J
156-59-2	cis-1,2-Dichloroethene	772	210	28	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	210	36	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID: 045162-95RSUBSOIL	
Lab Sample ID: M69502-1	Date Sampled: 12/05/07
Matrix: SO - Soil	Date Received: 12/05/07
Method: SW846 8260B	Percent Solids: 81.1
Project: GEI Tufts Street Somerville MA	

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	210	24	ug/kg	
142-28-9	1,3-Dichloropropane	ND	530	100	ug/kg	
594-20-7	2,2-Dichloropropane	ND	530	23	ug/kg	
563-58-6	1,1-Dichloropropene	ND	530	20	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	210	19	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	210	16	ug/kg	
123-91-1	1,4-Dioxane	ND	2700	1700	ug/kg	
60-29-7	Ethyl Ether	ND	530	44	ug/kg	
100-41-4	Ethylbenzene	ND	210	17	ug/kg	
87-68-3	Hexachlorobutadiene	ND	530	53	ug/kg	
591-78-6	2-Hexanone	ND	530	170	ug/kg	
98-82-8	Isopropylbenzene	ND	530	16	ug/kg	
99-87-6	p-Isopropyltoluene	ND	530	22	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	210	70	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	530	70	ug/kg	
74-95-3	Methylene bromide	ND	530	56	ug/kg	
75-09-2	Methylene chloride	ND	210	52	ug/kg	
91-20-3	Naphthalene	ND	530	40	ug/kg	
103-65-1	n-Propylbenzene	ND	530	11	ug/kg	
100-42-5	Styrene	ND	530	63	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	530	44	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	210	19	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	530	27	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	210	42	ug/kg	
127-18-4	Tetrachloroethene	42100	210	24	ug/kg	
109-99-9	Tetrahydrofuran	ND	1100	42	ug/kg	
108-88-3	Toluene	55.8	530	18	ug/kg	J
87-61-6	1,2,3-Trichlorobenzene	ND	530	73	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	530	42	ug/kg	
71-55-6	1,1,1-Trichloroethane	60.4	210	17	ug/kg	J
79-00-5	1,1,2-Trichloroethane	ND	210	30	ug/kg	
79-01-6	Trichloroethene	3310	210	28	ug/kg	
75-69-4	Trichlorofluoromethane	ND	210	16	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	530	66	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	530	21	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	530	21	ug/kg	
75-01-4	Vinyl chloride	ND	210	22	ug/kg	
	m,p-Xylene	ND	210	30	ug/kg	
95-47-6	o-Xylene	ND	210	19	ug/kg	
1330-20-7	Xylene (total)	ND	210	19	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Page 3 of 3

3.1

Client Sample ID: 045162-95RSUBSOIL
Lab Sample ID: M69502-1
Matrix: SO - Soil
Method: SW846 8260B
Project: GEI Tufts Street Somerville MA

Date Sampled: 12/05/07
Date Received: 12/05/07
Percent Solids: 81.1

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	94%		60-150%
2037-26-5	Toluene-D8	90%		73-125%
460-00-4	4-Bromofluorobenzene	104%		70-141%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Page 1 of 1

Client Sample ID: 045162-95RSUBSOIL

Lab Sample ID: M69502-1

Date Sampled: 12/05/07

Matrix: SO - Soil

Date Received: 12/05/07

Method: MADEP EPH REV 1.1 SW846 3535

Percent Solids: 81.1

Project: GEI Tufts Street Somerville MA

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	PO52325.D	1	12/06/07	SL	12/05/07	OP14860	GPO3085
Run #2							

	Initial Weight	Final Volume
Run #1	10.2 g	2.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
83-32-9	Acenaphthene	1080	600	480	ug/kg	
208-96-8	Acenaphthylene	ND	600	480	ug/kg	
120-12-7	Anthracene	2310	600	480	ug/kg	
56-55-3	Benzo(a)anthracene	5210	600	480	ug/kg	
50-32-8	Benzo(a)pyrene	6250	600	480	ug/kg	
205-99-2	Benzo(b)fluoranthene	6030	600	480	ug/kg	
191-24-2	Benzo(g,h,i)perylene	3640	600	480	ug/kg	
207-08-9	Benzo(k)fluoranthene	4600	600	480	ug/kg	
218-01-9	Chrysene	6730	600	480	ug/kg	
53-70-3	Dibenz(a,h)anthracene	959	600	480	ug/kg	
206-44-0	Fluoranthene	12600	600	480	ug/kg	
86-73-7	Fluorene	1630	600	480	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	4010	600	480	ug/kg	
91-57-6	2-Methylnaphthalene	ND	600	480	ug/kg	
91-20-3	Naphthalene	505	600	480	ug/kg	J
85-01-8	Phenanthrene	16400	600	480	ug/kg	
129-00-0	Pyrene	10200	600	480	ug/kg	
	C11-C22 Aromatics (Unadj.)	254000	24000	21000	ug/kg	
	C9-C18 Aliphatics	ND	12000	9700	ug/kg	
	C19-C36 Aliphatics	28900	12000	9700	ug/kg	
	C11-C22 Aromatics	171000	24000	21000	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
84-15-1	o-Terphenyl	98%		40-140%
321-60-8	2-Fluorobiphenyl	67%		40-140%
580-13-2	2-Bromonaphthalene	75%		40-140%
3386-33-2	1-Chlorooctadecane	43%		40-140%

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID:	045162-95RSUBSOIL	Date Sampled:	12/05/07
Lab Sample ID:	M69502-1	Date Received:	12/05/07
Matrix:	SO - Soil	Percent Solids:	81.1
Method:	SW846 8082 SW846 3545		
Project:	GEI Tufts Street Somerville MA		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	EF58940.D	1	12/06/07	SL	12/05/07	OP14855	GEF2818
Run #2							

	Initial Weight	Final Volume
Run #1	15.5 g	10.0 ml
Run #2		

PCB List

CAS No.	Compound	Result	RL	MDL	Units	Q
12674-11-2	Aroclor 1016	ND	120	16	ug/kg	
11104-28-2	Aroclor 1221	ND	120	6.0	ug/kg	
11141-16-5	Aroclor 1232	ND	120	13	ug/kg	
53469-21-9	Aroclor 1242	ND	120	9.8	ug/kg	
12672-29-6	Aroclor 1248	ND	120	8.1	ug/kg	
11097-69-1	Aroclor 1254	ND	120	7.3	ug/kg	
11096-82-5	Aroclor 1260	ND	120	12	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	103%		30-140%
877-09-8	Tetrachloro-m-xylene	112%		30-140%
2051-24-3	Decachlorobiphenyl	122%		30-150%
2051-24-3	Decachlorobiphenyl	125%		30-150%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Page 1 of 1

Client Sample ID: 045162-95RSUBSOIL

Lab Sample ID: M69502-1

Matrix: SO - Soil

Date Sampled: 12/05/07

Date Received: 12/05/07

Percent Solids: 81.1

Project: GEI Tufts Street Somerville MA

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Arsenic	36.4	2.4	mg/kg	1	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³
Barium	517	24	mg/kg	1	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³
Cadmium	1.8	0.49	mg/kg	1	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³
Chromium	25.0	1.2	mg/kg	1	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³
Lead	3580	12	mg/kg	5	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³
Mercury	5.2	0.40	mg/kg	10	12/07/07	12/07/07 MA	SW846 7471A ¹	SW846 7471A ⁴
Selenium	4.1	2.4	mg/kg	1	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³
Silver	1.2	0.61	mg/kg	1	12/06/07	12/07/07 PY	SW846 6010B ²	SW846 3050B ³

(1) Instrument QC Batch: MA8768

(2) Instrument QC Batch: MA8769

(3) Prep QC Batch: MP11245

(4) Prep QC Batch: MP11248

RL = Reporting Limit

Report of Analysis

Page 1 of 1

3.1

Client Sample ID: 045162-95RSUBSOIL

Lab Sample ID: M69502-1

Matrix: SO - Soil

Date Sampled: 12/05/07

Date Received: 12/05/07

Percent Solids: 81.1

Project: GEI Tufts Street Somerville MA

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Cyanide Reactivity	< 1.8	1.8	mg/kg	1	12/06/07	BF	SW846 CHAP7
Ignitability (Flashpoint)	> 230		Deg. F	1	12/06/07	BF	SW846 1020
Solids, Percent	81.1		%	1	12/06/07	NJ	SM21 2540 B MOD.
Specific Conductivity	401	0.50	umhos/cm	1	12/06/07	MA	EPA 120.1M
Sulfide Reactivity	< 62	62	mg/kg	1	12/06/07	BF	SW846 CHAP7

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RSUBSOIL
 Lab Sample ID: M69502-1R
 Matrix: SO - Soil
 Method: SW846 8260 SW846 1311
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/05/07
 Date Received: 12/05/07
 Percent Solids: 81.1

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	G76357.D	100	12/12/07	EL	12/11/07	GP8578	MSG3069
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCLP Leachate

TCLP Leachate method SW846 1311

CAS No.	Compound	Result	HW#	MCL	RL	MDL	Units	Q
71-43-2	Benzene	ND	D018	0.50	0.050	0.023	mg/l	
78-93-3	2-Butanone (MEK)	ND	D035	200	0.50	0.18	mg/l	
56-23-5	Carbon tetrachloride	ND	D019	0.50	0.20	0.021	mg/l	
108-90-7	Chlorobenzene	ND	D021	100	0.20	0.032	mg/l	
67-66-3	Chloroform	ND	D022	6.0	0.20	0.018	mg/l	
106-46-7	1,4-Dichlorobenzene	ND	D027	7.5	0.20	0.020	mg/l	
107-06-2	1,2-Dichloroethane	ND	D028	0.50	0.20	0.020	mg/l	
75-35-4	1,1-Dichloroethene	ND	D029	0.70	0.20	0.035	mg/l	
127-18-4	Tetrachloroethene	0.0418	D039	0.70	0.20	0.034	mg/l	J
79-01-6	Trichloroethene	ND	D040	0.50	0.20	0.030	mg/l	
75-01-4	Vinyl chloride	ND	D043	0.20	0.20	0.024	mg/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	95%		84-129%
2037-26-5	Toluene-D8	101%		80-120%
460-00-4	4-Bromofluorobenzene	90%		82-118%

ND = Not detected MDL - Method Detection Limit
 MCL = Maximum Contamination Level (40 CFR 261.6/96)
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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2.1

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Client Sample ID: 045162-95RSUBSOIL

Lab Sample ID: M69502-1R

Matrix: SO - Soil

Date Sampled: 12/05/07

Date Received: 12/05/07

Percent Solids: 81.1

Project: GEI Tufts Street Somerville MA

Metals Analysis, TCLP Leachate SW846 1311

Analyte	Result	HW#	MCL	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Lead	2.0	D008	5.0	0.010	mg/l	1	12/12/07	12/12/07 PY	SW846 6010B ¹	SW846 3010A ²

(1) Instrument QC Batch: MA8781

(2) Prep QC Batch: MP11268

RL = Reporting Limit

MCL = Maximum Contamination Level (40 CFR 261.6/96)

Report of Analysis

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3.1

Client Sample ID: 045162-95RSUBSOIL

Lab Sample ID: M69502-1X

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/05/07

Date Received: 12/05/07

Percent Solids: 81.1

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Total Organic Carbon	203000	13000	mg/kg	1	12/17/07 12:32	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID:	045162-95FRANK-NORTH FILL	Date Sampled:	12/11/07
Lab Sample ID:	M69727-1	Date Received:	12/13/07
Matrix:	SO - Soil	Percent Solids:	78.5
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

Run #1	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #2	H43931.D	1	12/17/07	SC	n/a	n/a	MSH1361

Run #1	Initial Weight	Final Volume	Methanol Aliquot
Run #2	7.91 g	10.0 ml	100 ul

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	470	310	ug/kg	
71-43-2	Benzene	ND	47	17	ug/kg	
108-86-1	Bromobenzene	ND	470	35	ug/kg	
74-97-5	Bromochloromethane	ND	470	90	ug/kg	
75-27-4	Bromodichloromethane	ND	190	18	ug/kg	
75-25-2	Bromoform	ND	190	35	ug/kg	
74-83-9	Bromomethane	ND	190	42	ug/kg	
78-93-3	2-Butanone (MEK)	ND	470	130	ug/kg	
104-51-8	n-Butylbenzene	ND	470	20	ug/kg	
135-98-8	sec-Butylbenzene	ND	470	14	ug/kg	
98-06-6	tert-Butylbenzene	ND	470	18	ug/kg	
75-15-0	Carbon disulfide	ND	470	46	ug/kg	
56-23-5	Carbon tetrachloride	ND	190	15	ug/kg	
108-90-7	Chlorobenzene	ND	190	15	ug/kg	
75-00-3	Chloroethane	ND	470	24	ug/kg	
67-66-3	Chloroform	ND	190	58	ug/kg	
74-87-3	Chloromethane	ND	470	29	ug/kg	
95-49-8	o-Chlorotoluene	ND	470	17	ug/kg	
106-43-4	p-Chlorotoluene	ND	470	32	ug/kg	
108-20-3	Di-Isopropyl ether	ND	190	13	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	470	160	ug/kg	
124-48-1	Dibromochloromethane	ND	190	27	ug/kg	
106-93-4	1,2-Dibromoethane	ND	190	25	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	190	16	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	190	33	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	190	41	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	190	11	ug/kg	
75-34-3	1,1-Dichloroethane	ND	190	25	ug/kg	
107-06-2	1,2-Dichloroethane	ND	190	12	ug/kg	
75-35-4	1,1-Dichloroethene	ND	190	31	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	190	25	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	190	32	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Page 2 of 3

Client Sample ID: 045162-95FRANK-NORTH FILL	
Lab Sample ID: M69727-1	Date Sampled: 12/11/07
Matrix: SO - Soil	Date Received: 12/13/07
Method: SW846 8260B	Percent Solids: 78.5
Project: GEI Tufts Street Somerville MA	

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	190	21	ug/kg	
142-28-9	1,3-Dichloropropane	ND	470	93	ug/kg	
594-20-7	2,2-Dichloropropane	ND	470	20	ug/kg	
563-58-6	1,1-Dichloropropene	ND	470	17	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	190	17	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	190	15	ug/kg	
123-91-1	1,4-Dioxane	ND	2400	1500	ug/kg	
60-29-7	Ethyl Ether	ND	470	39	ug/kg	
100-41-4	Ethylbenzene	ND	190	15	ug/kg	
87-68-3	Hexachlorobutadiene	ND	470	47	ug/kg	
591-78-6	2-Hexanone	ND	470	150	ug/kg	
98-82-8	Isopropylbenzene	ND	470	14	ug/kg	
99-87-6	p-Isopropyltoluene	ND	470	19	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	190	62	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	470	62	ug/kg	
74-95-3	Methylene bromide	ND	470	50	ug/kg	
75-09-2	Methylene chloride	ND	190	46	ug/kg	
91-20-3	Naphthalene	ND	470	35	ug/kg	
103-65-1	n-Propylbenzene	ND	470	9.5	ug/kg	
100-42-5	Styrene	ND	470	56	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	470	39	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	190	17	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	470	24	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	190	37	ug/kg	
127-18-4	Tetrachloroethene	1140	190	22	ug/kg	
109-99-9	Tetrahydrofuran	ND	940	37	ug/kg	
108-88-3	Toluene	ND	470	16	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	470	65	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	470	37	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	190	15	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	190	27	ug/kg	
79-01-6	Trichloroethene	268	190	25	ug/kg	
75-69-4	Trichlorofluoromethane	ND	190	14	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	470	58	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	470	19	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	470	19	ug/kg	
75-01-4	Vinyl chloride	ND	190	20	ug/kg	
	m,p-Xylene	ND	190	27	ug/kg	
95-47-6	o-Xylene	ND	190	17	ug/kg	
1330-20-7	Xylene (total)	ND	190	17	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

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Client Sample ID: 045162-95FRANK-NORTH FILL	
Lab Sample ID: M69727-1	Date Sampled: 12/11/07
Matrix: SO - Soil	Date Received: 12/13/07
Method: SW846 8260B	Percent Solids: 78.5
Project: GEI Tufts Street Somerville MA	

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	96%		60-150%
2037-26-5	Toluene-D8	93%		73-125%
460-00-4	4-Bromofluorobenzene	96%		70-141%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95FRANK-NORTH FILL
 Lab Sample ID: M69727-1
 Matrix: SO - Soil
 Method: SW846 8270C SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/11/07
 Date Received: 12/13/07
 Percent Solids: 78.5

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	I50697.D	1	12/20/07	AT	12/18/07	OP14922	MSI1586
Run #2							

Run #	Initial Weight	Final Volume
Run #1	20.4 g	1.0 ml
Run #2		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
65-85-0	Benzoic acid	ND	630	20	ug/kg	
95-57-8	2-Chlorophenol	ND	310	19	ug/kg	
59-50-7	4-Chloro-3-methyl phenol	ND	630	16	ug/kg	
120-83-2	2,4-Dichlorophenol	ND	630	38	ug/kg	
105-67-9	2,4-Dimethylphenol	ND	630	96	ug/kg	
51-28-5	2,4-Dinitrophenol	ND	1300	54	ug/kg	
95-48-7	2-Methylphenol	ND	630	19	ug/kg	
	3&4-Methylphenol	ND	630	24	ug/kg	
88-75-5	2-Nitrophenol	ND	630	8.0	ug/kg	
100-02-7	4-Nitrophenol	ND	1300	120	ug/kg	
87-86-5	Pentachlorophenol	ND	630	300	ug/kg	
108-95-2	Phenol	ND	310	310	ug/kg	
95-95-4	2,4,5-Trichlorophenol	ND	630	20	ug/kg	
88-06-2	2,4,6-Trichlorophenol	ND	630	9.4	ug/kg	
83-32-9	Acenaphthene	ND	310	12	ug/kg	
208-96-8	Acenaphthylene	57.1	310	7.9	ug/kg	J
98-86-2	Acetophenone	ND	630	8.3	ug/kg	
62-53-3	Aniline	ND	630	40	ug/kg	
120-12-7	Anthracene	153	310	7.0	ug/kg	J
56-55-3	Benzo(a)anthracene	504	310	8.6	ug/kg	
50-32-8	Benzo(a)pyrene	514	310	36	ug/kg	
205-99-2	Benzo(b)fluoranthene	814	310	11	ug/kg	
191-24-2	Benzo(g,h,i)perylene	575	310	12	ug/kg	
207-08-9	Benzo(k)fluoranthene	464	310	9.6	ug/kg	
101-55-3	4-Bromophenyl phenyl ether	ND	310	13	ug/kg	
85-68-7	Butyl benzyl phthalate	ND	310	10	ug/kg	
91-58-7	2-Chloronaphthalene	ND	310	8.4	ug/kg	
106-47-8	4-Chloroaniline	ND	630	27	ug/kg	
218-01-9	Chrysene	509	310	9.8	ug/kg	
111-91-1	bis(2-Chloroethoxy)methane	ND	310	14	ug/kg	
111-44-4	bis(2-Chloroethyl)ether	ND	310	13	ug/kg	
108-60-1	bis(2-Chloroisopropyl)ether	ND	310	7.0	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

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Client Sample ID:	045162-95FRANK-NORTH FILL		
Lab Sample ID:	M69727-1	Date Sampled:	12/11/07
Matrix:	SO - Soil	Date Received:	12/13/07
Method:	SW846 8270C SW846 3545	Percent Solids:	78.5
Project:	GEI Tufts Street Somerville MA		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
95-50-1	1,2-Dichlorobenzene	ND	310	14	ug/kg	
122-66-7	1,2-Diphenylhydrazine	ND	310	4.9	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	310	12	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	310	14	ug/kg	
121-14-2	2,4-Dinitrotoluene	ND	630	8.4	ug/kg	
606-20-2	2,6-Dinitrotoluene	ND	630	16	ug/kg	
91-94-1	3,3'-Dichlorobenzidine	ND	310	44	ug/kg	
53-70-3	Dibenzo(a,h)anthracene	271	310	14	ug/kg	J
132-64-9	Dibenzofuran	ND	310	11	ug/kg	
84-74-2	Di-n-butyl phthalate	ND	310	12	ug/kg	
117-84-0	Di-n-octyl phthalate	ND	310	32	ug/kg	
84-66-2	Diethyl phthalate	ND	310	9.8	ug/kg	
131-11-3	Dimethyl phthalate	ND	310	7.2	ug/kg	
117-81-7	bis(2-Ethylhexyl)phthalate	ND	310	23	ug/kg	
206-44-0	Fluoranthene	1100	310	13	ug/kg	
86-73-7	Fluorene	37.9	310	10	ug/kg	J
118-74-1	Hexachlorobenzene	ND	310	11	ug/kg	
87-68-3	Hexachlorobutadiene	ND	310	18	ug/kg	
77-47-4	Hexachlorocyclopentadiene	ND	630	15	ug/kg	
67-72-1	Hexachloroethane	ND	310	11	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	518	310	20	ug/kg	
78-59-1	Isophorone	ND	310	12	ug/kg	
91-57-6	2-Methylnaphthalene	ND	310	11	ug/kg	
91-20-3	Naphthalene	63.8	310	13	ug/kg	J
98-95-3	Nitrobenzene	ND	310	17	ug/kg	
621-64-7	N-Nitroso-di-n-propylamine	ND	310	16	ug/kg	
86-30-6	N-Nitrosodiphenylamine	ND	310	6.7	ug/kg	
85-01-8	Phenanthrene	663	310	4.9	ug/kg	
129-00-0	Pyrene	939	310	4.4	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	310	11	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
367-12-4	2-Fluorophenol	55%		20-120%
4165-62-2	Phenol-d5	60%		23-120%
118-79-6	2,4,6-Tribromophenol	80%		10-120%
4165-60-0	Nitrobenzene-d5	56%		20-118%
321-60-8	2-Fluorobiphenyl	70%		30-115%
1718-51-0	Terphenyl-d14	74%		32-126%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95FRANK-NORTH FILL
 Lab Sample ID: M69727-1
 Matrix: SO - Soil
 Method: MADEP EPH REV 1.1 SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/11/07
 Date Received: 12/13/07
 Percent Solids: 78.5

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	PO52444.D	1	12/19/07	SL	12/14/07	OP14905	GPO3093
Run #2							

	Initial Weight	Final Volume
Run #1	10.4 g	2.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
83-32-9	Acenaphthene	ND	620	490	ug/kg	
208-96-8	Acenaphthylene	ND	620	490	ug/kg	
120-12-7	Anthracene	ND	620	490	ug/kg	
56-55-3	Benzo(a)anthracene	ND	620	490	ug/kg	
50-32-8	Benzo(a)pyrene	ND	620	490	ug/kg	
205-99-2	Benzo(b)fluoranthene	ND	620	490	ug/kg	
191-24-2	Benzo(g,h,i)perylene	ND	620	490	ug/kg	
207-08-9	Benzo(k)fluoranthene	ND	620	490	ug/kg	
218-01-9	Chrysene	527	620	490	ug/kg	J
53-70-3	Dibenz(a,h)anthracene	ND	620	490	ug/kg	
206-44-0	Fluoranthene	837	620	490	ug/kg	
86-73-7	Fluorene	ND	620	490	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	ND	620	490	ug/kg	
91-57-6	2-Methylnaphthalene	ND	620	490	ug/kg	
91-20-3	Naphthalene	ND	620	490	ug/kg	
85-01-8	Phenanthrene	500	620	490	ug/kg	J
129-00-0	Pyrene	733	620	490	ug/kg	
	C11-C22 Aromatics (Unadj.)	ND	25000	21000	ug/kg	
	C9-C18 Aliphatics	ND	12000	9800	ug/kg	
	C19-C36 Aliphatics	ND	12000	9800	ug/kg	
	C11-C22 Aromatics	ND	25000	21000	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
84-15-1	o-Terphenyl	72%		40-140%
321-60-8	2-Fluorobiphenyl	65%		40-140%
580-13-2	2-Bromonaphthalene	63%		40-140%
3386-33-2	1-Chlorooctadecane	52%		40-140%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95FRANK-NORTH FILL
 Lab Sample ID: M69727-1
 Matrix: SO - Soil
 Method: SW846 8082 SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/11/07
 Date Received: 12/13/07
 Percent Solids: 78.5

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	EF59100.D	1	12/18/07	SL	12/17/07	OP14913	GEF2825
Run #2							

Run #	Initial Weight	Final Volume
Run #1	15.7 g	10.0 ml
Run #2		

PCB List

CAS No.	Compound	Result	RL	MDL	Units	Q
12674-11-2	Aroclor 1016	ND	120	17	ug/kg	
11104-28-2	Aroclor 1221	ND	120	6.2	ug/kg	
11141-16-5	Aroclor 1232	ND	120	14	ug/kg	
53469-21-9	Aroclor 1242	ND	120	10	ug/kg	
12672-29-6	Aroclor 1248	ND	120	8.2	ug/kg	
11097-69-1	Aroclor 1254	ND	120	7.4	ug/kg	
11096-82-5	Aroclor 1260	ND	120	12	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	93%		30-140%
877-09-8	Tetrachloro-m-xylene	101%		30-140%
2051-24-3	Decachlorobiphenyl	150%		30-150%
2051-24-3	Decachlorobiphenyl	170% ^a		30-150%

(a) Outside control limits due to possible matrix interference.

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID:	045162-95FRANK-NORTH FILL	Date Sampled:	12/11/07
Lab Sample ID:	M69727-1	Date Received:	12/13/07
Matrix:	SO - Soil	Percent Solids:	78.5
Project:	GEI Tufts Street Somerville MA		

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Arsenic	19.3	2.4	mg/kg	1	12/15/07	12/17/07 PY	SW846 6010B ¹	SW846 3050B ⁴
Cadmium	0.53	0.49	mg/kg	1	12/15/07	12/17/07 PY	SW846 6010B ¹	SW846 3050B ⁴
Chromium	17.0	1.2	mg/kg	1	12/15/07	12/17/07 PY	SW846 6010B ¹	SW846 3050B ⁴
Lead	1890	4.9	mg/kg	2	12/15/07	12/18/07 PY	SW846 6010B ²	SW846 3050B ⁴
Mercury	0.79	0.039	mg/kg	1	12/18/07	12/19/07 MA	SW846 7471A ³	SW846 7471A ⁵

- (1) Instrument QC Batch: MA8802
(2) Instrument QC Batch: MA8804
(3) Instrument QC Batch: MA8807
(4) Prep QC Batch: MP11288
(5) Prep QC Batch: MP11293

RL = Reporting Limit

Report of Analysis

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3.1

Client Sample ID: 045162-95FRANK-NORTH FILL

Lab Sample ID: M69727-1

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/11/07

Date Received: 12/13/07

Percent Solids: 78.5

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Corrosivity as pH	7.7			1	12/17/07	MA	SW846 CHAP7
Cyanide Reactivity	< 1.9	1.9	mg/kg	1	12/19/07	BF	SW846 CHAP7
Ignitability (Flashpoint)	> 230		Deg. F	1	12/19/07	MA	SW846 1020
Solids, Percent	78.5		%	1	12/14/07	NJ	SM21 2540 B MOD.
Specific Conductivity	382	0.50	umhos/cm	1	12/18/07	MA	EPA 120.1M
Sulfide Reactivity	< 64	64	mg/kg	1	12/19/07	BF	SW846 CHAP7
Total Organic Carbon	84000	12000	mg/kg	1	12/17/07 11:58	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

Page 1 of 3

Client Sample ID: 045162-95FRANK-NORTH SILT

Lab Sample ID: M69727-2

Date Sampled: 12/11/07

Matrix: SO - Soil

Date Received: 12/13/07

Method: SW846 8260B

Percent Solids: 82.2

Project: GEI Tufts Street Somerville MA

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H44006.D	1	12/21/07	SC	n/a	n/a	MSH1363
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	8.25 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	420	280	ug/kg	
71-43-2	Benzene	ND	42	15	ug/kg	
108-86-1	Bromobenzene	ND	420	31	ug/kg	
74-97-5	Bromochloromethane	ND	420	81	ug/kg	
75-27-4	Bromodichloromethane	ND	170	16	ug/kg	
75-25-2	Bromoform	ND	170	31	ug/kg	
74-83-9	Bromomethane	ND	170	38	ug/kg	
78-93-3	2-Butanone (MEK)	ND	420	110	ug/kg	
104-51-8	n-Butylbenzene	ND	420	18	ug/kg	
135-98-8	sec-Butylbenzene	ND	420	12	ug/kg	
98-06-6	tert-Butylbenzene	ND	420	16	ug/kg	
75-15-0	Carbon disulfide	ND	420	41	ug/kg	
56-23-5	Carbon tetrachloride	ND	170	13	ug/kg	
108-90-7	Chlorobenzene	ND	170	13	ug/kg	
75-00-3	Chloroethane	ND	420	22	ug/kg	
67-66-3	Chloroform	ND	170	52	ug/kg	
74-87-3	Chloromethane	ND	420	26	ug/kg	
95-49-8	o-Chlorotoluene	ND	420	15	ug/kg	
106-43-4	p-Chlorotoluene	ND	420	29	ug/kg	
108-20-3	Di-Isopropyl ether	ND	170	11	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	420	140	ug/kg	
124-48-1	Dibromochloromethane	ND	170	24	ug/kg	
106-93-4	1,2-Dibromoethane	ND	170	22	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	170	15	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	170	30	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	170	37	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	170	10	ug/kg	
75-34-3	1,1-Dichloroethane	ND	170	22	ug/kg	
107-06-2	1,2-Dichloroethane	ND	170	11	ug/kg	
75-35-4	1,1-Dichloroethene	ND	170	27	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	170	22	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	170	29	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.2

3

Client Sample ID: 045162-95FRANK-NORTH SILT

Lab Sample ID: M69727-2

Date Sampled: 12/11/07

Matrix: SO - Soil

Date Received: 12/13/07

Method: SW846 8260B

Percent Solids: 82.2

Project: GEI Tufts Street Somerville MA

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	170	19	ug/kg	
142-28-9	1,3-Dichloropropane	ND	420	83	ug/kg	
594-20-7	2,2-Dichloropropane	ND	420	18	ug/kg	
563-58-6	1,1-Dichloropropene	ND	420	16	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	170	15	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	170	13	ug/kg	
123-91-1	1,4-Dioxane	ND	2100	1400	ug/kg	
60-29-7	Ethyl Ether	ND	420	35	ug/kg	
100-41-4	Ethylbenzene	ND	170	13	ug/kg	
87-68-3	Hexachlorobutadiene	ND	420	42	ug/kg	
591-78-6	2-Hexanone	ND	420	130	ug/kg	
98-82-8	Isopropylbenzene	ND	420	13	ug/kg	
99-87-6	p-Isopropyltoluene	ND	420	17	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	170	56	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	420	56	ug/kg	
74-95-3	Methylene bromide	ND	420	45	ug/kg	
75-09-2	Methylene chloride	81.8	170	41	ug/kg	JB
91-20-3	Naphthalene	ND	420	32	ug/kg	
103-65-1	n-Propylbenzene	ND	420	8.5	ug/kg	
100-42-5	Styrene	ND	420	50	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	420	35	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	170	15	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	420	21	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	170	33	ug/kg	
127-18-4	Tetrachloroethene	ND	170	19	ug/kg	
109-99-9	Tetrahydrofuran	ND	850	34	ug/kg	
108-88-3	Toluene	ND	420	14	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	420	58	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	420	34	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	170	14	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	170	24	ug/kg	
79-01-6	Trichloroethene	ND	170	22	ug/kg	
75-69-4	Trichlorofluoromethane	ND	170	13	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	420	52	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	420	17	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	420	17	ug/kg	
75-01-4	Vinyl chloride	ND	170	18	ug/kg	
	m,p-Xylene	ND	170	24	ug/kg	
95-47-6	o-Xylene	ND	170	15	ug/kg	
1330-20-7	Xylene (total)	ND	170	15	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.2

3

Client Sample ID:	045162-95FRANK-NORTH SILT	Date Sampled:	12/11/07
Lab Sample ID:	M69727-2	Date Received:	12/13/07
Matrix:	SO - Soil	Percent Solids:	82.2
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	108%		60-150%
2037-26-5	Toluene-D8	101%		73-125%
460-00-4	4-Bromofluorobenzene	104%		70-141%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Page 1 of 1



Client Sample ID: 045162-95FRANK-NORTH SILT

Lab Sample ID: M69727-2

Date Sampled: 12/11/07

Matrix: SO - Soil

Date Received: 12/13/07

Percent Solids: 82.2

Project: GEI Tufts Street Somerville MA

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	82.2		%	1	12/20/07	CF	SM21 2540 B MOD.
Total Organic Carbon	5730	1200	mg/kg	1	12/20/07 17:23	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95FRANK-SOUTH FILL
 Lab Sample ID: M69727-3
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/11/07
 Date Received: 12/13/07
 Percent Solids: 83.3

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H44007.D	1	12/21/07	SC	n/a	n/a	MSH1363
Run #2	H44031.D	1	12/24/07	SC	n/a	n/a	MSH1363

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	5.01 g	10.0 ml	100 ul
Run #2	5.01 g	10.0 ml	10.0 ul

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	650	420	ug/kg	
71-43-2	Benzene	156	65	23	ug/kg	
108-86-1	Bromobenzene	ND	650	48	ug/kg	
74-97-5	Bromochloromethane	ND	650	120	ug/kg	
75-27-4	Bromodichloromethane	ND	260	24	ug/kg	
75-25-2	Bromoform	ND	260	48	ug/kg	
74-83-9	Bromomethane	ND	260	59	ug/kg	
78-93-3	2-Butanone (MEK)	ND	650	180	ug/kg	
104-51-8	n-Butylbenzene	ND	650	27	ug/kg	
135-98-8	sec-Butylbenzene	ND	650	19	ug/kg	
98-06-6	tert-Butylbenzene	ND	650	25	ug/kg	
75-15-0	Carbon disulfide	ND	650	63	ug/kg	
56-23-5	Carbon tetrachloride	ND	260	21	ug/kg	
108-90-7	Chlorobenzene	ND	260	21	ug/kg	
75-00-3	Chloroethane	ND	650	34	ug/kg	
67-66-3	Chloroform	ND	260	80	ug/kg	
74-87-3	Chloromethane	ND	650	39	ug/kg	
95-49-8	o-Chlorotoluene	ND	650	23	ug/kg	
106-43-4	p-Chlorotoluene	ND	650	44	ug/kg	
108-20-3	Di-Isopropyl ether	ND	260	18	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	650	220	ug/kg	
124-48-1	Dibromochloromethane	ND	260	37	ug/kg	
106-93-4	1,2-Dibromoethane	ND	260	34	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	260	22	ug/kg	
541-73-1	1,3-Dichlorobenzene	520	260	46	ug/kg	
106-46-7	1,4-Dichlorobenzene	365	260	57	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	260	16	ug/kg	
75-34-3	1,1-Dichloroethane	ND	260	34	ug/kg	
107-06-2	1,2-Dichloroethane	ND	260	17	ug/kg	
75-35-4	1,1-Dichloroethene	491	260	42	ug/kg	
156-59-2	cis-1,2-Dichloroethene	674	260	34	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	260	44	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	045162-95FRANK-SOUTH FILL		
Lab Sample ID:	M69727-3	Date Sampled:	12/11/07
Matrix:	SO - Soil	Date Received:	12/13/07
Method:	SW846 8260B	Percent Solids:	83.3
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	260	29	ug/kg	
142-28-9	1,3-Dichloropropane	ND	650	130	ug/kg	
594-20-7	2,2-Dichloropropane	ND	650	28	ug/kg	
563-58-6	1,1-Dichloropropene	ND	650	24	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	260	23	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	260	20	ug/kg	
123-91-1	1,4-Dioxane	ND	3200	2100	ug/kg	
60-29-7	Ethyl Ether	ND	650	54	ug/kg	
100-41-4	Ethylbenzene	96.0	260	21	ug/kg	J
87-68-3	Hexachlorobutadiene	ND	650	65	ug/kg	
591-78-6	2-Hexanone	ND	650	200	ug/kg	
98-82-8	Isopropylbenzene	ND	650	19	ug/kg	
99-87-6	p-Isopropyltoluene	ND	650	27	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	260	86	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	650	85	ug/kg	
74-95-3	Methylene bromide	ND	650	69	ug/kg	
75-09-2	Methylene chloride	205	260	63	ug/kg	JB
91-20-3	Naphthalene	198	650	48	ug/kg	J
103-65-1	n-Propylbenzene	ND	650	13	ug/kg	
100-42-5	Styrene	ND	650	77	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	650	54	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	260	23	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	650	33	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	260	51	ug/kg	
127-18-4	Tetrachloroethene	58900 ^a	2600	300	ug/kg	
109-99-9	Tetrahydrofuran	ND	1300	52	ug/kg	
108-88-3	Toluene	264	650	21	ug/kg	J
87-61-6	1,2,3-Trichlorobenzene	ND	650	90	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	650	52	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	260	21	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	260	37	ug/kg	
79-01-6	Trichloroethene	6170	260	34	ug/kg	
75-69-4	Trichlorofluoromethane	ND	260	19	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	650	80	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	268	650	26	ug/kg	J
108-67-8	1,3,5-Trimethylbenzene	ND	650	26	ug/kg	
75-01-4	Vinyl chloride	ND	260	27	ug/kg	
	m,p-Xylene	575	260	37	ug/kg	
95-47-6	o-Xylene	141	260	23	ug/kg	J
1330-20-7	Xylene (total)	716	260	23	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID:	045162-95FRANK-SOUTH FILL	Date Sampled:	12/11/07
Lab Sample ID:	M69727-3	Date Received:	12/13/07
Matrix:	SO - Soil	Percent Solids:	83.3
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	107%	114%	60-150%
2037-26-5	Toluene-D8	99%	103%	73-125%
460-00-4	4-Bromofluorobenzene	99%	107%	70-141%

(a) Result is from Run# 2

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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33

Client Sample ID: 045162-95FRANK-SOUTH FILL

Lab Sample ID: M69727-3

Date Sampled: 12/11/07

Matrix: SO - Soil

Date Received: 12/13/07

Percent Solids: 83,3

Project: GEI Tufts Street Somerville MA

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	83.3		%	1	12/20/07	CF	SM21 2540 B MOD.
Total Organic Carbon	351000	9900	mg/kg	1	12/20/07 19:47	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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3.4

Client Sample ID:	045162-95FRANK-SOUTH SILT	Date Sampled:	12/11/07
Lab Sample ID:	M69727-4	Date Received:	12/13/07
Matrix:	SO - Soil	Percent Solids:	82.1
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H44008.D	1	12/21/07	SC	n/a	n/a	MSH1363
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	8.49 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	410	270	ug/kg	
71-43-2	Benzene	ND	41	15	ug/kg	
108-86-1	Bromobenzene	ND	410	30	ug/kg	
74-97-5	Bromochloromethane	ND	410	79	ug/kg	
75-27-4	Bromodichloromethane	ND	170	15	ug/kg	
75-25-2	Bromoform	ND	170	31	ug/kg	
74-83-9	Bromomethane	ND	170	37	ug/kg	
78-93-3	2-Butanone (MEK)	ND	410	110	ug/kg	
104-51-8	n-Butylbenzene	ND	410	17	ug/kg	
135-98-8	sec-Butylbenzene	ND	410	12	ug/kg	
98-06-6	tert-Butylbenzene	ND	410	16	ug/kg	
75-15-0	Carbon disulfide	ND	410	40	ug/kg	
56-23-5	Carbon tetrachloride	ND	170	13	ug/kg	
108-90-7	Chlorobenzene	ND	170	13	ug/kg	
75-00-3	Chloroethane	ND	410	21	ug/kg	
67-66-3	Chloroform	ND	170	51	ug/kg	
74-87-3	Chloromethane	ND	410	25	ug/kg	
95-49-8	o-Chlorotoluene	ND	410	15	ug/kg	
106-43-4	p-Chlorotoluene	ND	410	28	ug/kg	
108-20-3	Di-Isopropyl ether	ND	170	11	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	410	140	ug/kg	
124-48-1	Dibromochloromethane	ND	170	23	ug/kg	
106-93-4	1,2-Dibromoethane	ND	170	22	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	170	14	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	170	29	ug/kg	
106-46-7	1,4-Dichlorobenzene	74.0	170	36	ug/kg	J
75-71-8	Dichlorodifluoromethane	ND	170	10	ug/kg	
75-34-3	1,1-Dichloroethane	ND	170	22	ug/kg	
107-06-2	1,2-Dichloroethane	ND	170	11	ug/kg	
75-35-4	1,1-Dichloroethene	ND	170	27	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	170	22	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	170	28	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.4

Client Sample ID:	045162-95FRANK-SOUTH SILT		
Lab Sample ID:	M69727-4	Date Sampled:	12/11/07
Matrix:	SO - Soil	Date Received:	12/13/07
Method:	SW846 8260B	Percent Solids:	82.1
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	170	19	ug/kg	
142-28-9	1,3-Dichloropropane	ND	410	81	ug/kg	
594-20-7	2,2-Dichloropropane	ND	410	18	ug/kg	
563-58-6	1,1-Dichloropropene	ND	410	15	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	170	15	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	170	13	ug/kg	
123-91-1	1,4-Dioxane	ND	2100	1300	ug/kg	
60-29-7	Ethyl Ether	ND	410	34	ug/kg	
100-41-4	Ethylbenzene	ND	170	13	ug/kg	
87-68-3	Hexachlorobutadiene	ND	410	41	ug/kg	
591-78-6	2-Hexanone	ND	410	130	ug/kg	
98-82-8	Isopropylbenzene	ND	410	12	ug/kg	
99-87-6	p-Isopropyltoluene	ND	410	17	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	170	55	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	410	54	ug/kg	
74-95-3	Methylene bromide	ND	410	44	ug/kg	
75-09-2	Methylene chloride	82.7	170	40	ug/kg	JB
91-20-3	Naphthalene	ND	410	31	ug/kg	
103-65-1	n-Propylbenzene	ND	410	8.3	ug/kg	
100-42-5	Styrene	ND	410	49	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	410	34	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	170	15	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	410	21	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	170	33	ug/kg	
127-18-4	Tetrachloroethene	38.1	170	19	ug/kg	J
109-99-9	Tetrahydrofuran	ND	830	33	ug/kg	
108-88-3	Toluene	ND	410	14	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	410	57	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	410	33	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	170	14	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	170	23	ug/kg	
79-01-6	Trichloroethene	ND	170	22	ug/kg	
75-69-4	Trichlorofluoromethane	ND	170	12	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	410	51	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	410	16	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	410	17	ug/kg	
75-01-4	Vinyl chloride	ND	170	17	ug/kg	
	m,p-Xylene	ND	170	24	ug/kg	
95-47-6	o-Xylene	ND	170	15	ug/kg	
1330-20-7	Xylene (total)	ND	170	15	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.4

Client Sample ID:	045162-95FRANK-SOUTH SILT	Date Sampled:	12/11/07
Lab Sample ID:	M69727-4	Date Received:	12/13/07
Matrix:	SO - Soil	Percent Solids:	82.1
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	101%		60-150%
2037-26-5	Toluene-D8	95%		73-125%
460-00-4	4-Bromofluorobenzene	97%		70-141%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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3.4

Client Sample ID: 045162-95FRANK-SOUTH SILT

Lab Sample ID: M69727-4

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/11/07

Date Received: 12/13/07

Percent Solids: 82.1

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	82.1		%	1	12/20/07	CF	SM21 2540 B MOD.
Total Organic Carbon	1560	1200	mg/kg	1	12/20/07 17:54	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RFRANK-EASTSILT
 Lab Sample ID: M69764-1
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 85.4

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H43973.D	1	12/18/07	PB	n/a	n/a	MSH1362
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	6.61 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	490	320	ug/kg	
71-43-2	Benzene	ND	49	17	ug/kg	
108-86-1	Bromobenzene	ND	490	36	ug/kg	
74-97-5	Bromochloromethane	ND	490	93	ug/kg	
75-27-4	Bromodichloromethane	ND	190	18	ug/kg	
75-25-2	Bromoform	ND	190	36	ug/kg	
74-83-9	Bromomethane	ND	190	44	ug/kg	
78-93-3	2-Butanone (MEK)	ND	490	130	ug/kg	
104-51-8	n-Butylbenzene	ND	490	20	ug/kg	
135-98-8	sec-Butylbenzene	ND	490	14	ug/kg	
98-06-6	tert-Butylbenzene	ND	490	19	ug/kg	
75-15-0	Carbon disulfide	ND	490	47	ug/kg	
56-23-5	Carbon tetrachloride	ND	190	15	ug/kg	
108-90-7	Chlorobenzene	ND	190	15	ug/kg	
75-00-3	Chloroethane	ND	490	25	ug/kg	
67-66-3	Chloroform	ND	190	60	ug/kg	
74-87-3	Chloromethane	ND	490	29	ug/kg	
95-49-8	o-Chlorotoluene	ND	490	17	ug/kg	
106-43-4	p-Chlorotoluene	ND	490	33	ug/kg	
108-20-3	Di-Isopropyl ether	ND	190	13	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	490	160	ug/kg	
124-48-1	Dibromochloromethane	ND	190	27	ug/kg	
106-93-4	1,2-Dibromoethane	ND	190	26	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	190	17	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	190	34	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	190	42	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	190	12	ug/kg	
75-34-3	1,1-Dichloroethane	ND	190	26	ug/kg	
107-06-2	1,2-Dichloroethane	ND	190	13	ug/kg	
75-35-4	1,1-Dichloroethene	ND	190	32	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	190	25	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	190	33	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID:	045162-95RFRANK-EASTSILT	Date Sampled:	12/14/07
Lab Sample ID:	M69764-1	Date Received:	12/17/07
Matrix:	SO - Soil	Percent Solids:	85.4
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	190	22	ug/kg	
142-28-9	1,3-Dichloropropane	ND	490	95	ug/kg	
594-20-7	2,2-Dichloropropane	ND	490	21	ug/kg	
563-58-6	1,1-Dichloropropene	ND	490	18	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	190	17	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	190	15	ug/kg	
123-91-1	1,4-Dioxane	ND	2400	1600	ug/kg	
60-29-7	Ethyl Ether	ND	490	41	ug/kg	
100-41-4	Ethylbenzene	ND	190	15	ug/kg	
87-68-3	Hexachlorobutadiene	ND	490	48	ug/kg	
591-78-6	2-Hexanone	ND	490	150	ug/kg	
98-82-8	Isopropylbenzene	ND	490	14	ug/kg	
99-87-6	p-Isopropyltoluene	ND	490	20	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	190	64	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	490	64	ug/kg	
74-95-3	Methylene bromide	ND	490	51	ug/kg	
75-09-2	Methylene chloride	ND	190	47	ug/kg	
91-20-3	Naphthalene	ND	490	36	ug/kg	
103-65-1	n-Propylbenzene	ND	490	9.8	ug/kg	
100-42-5	Styrene	ND	490	58	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	490	40	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	190	17	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	490	24	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	190	38	ug/kg	
127-18-4	Tetrachloroethene	3340	190	22	ug/kg	
109-99-9	Tetrahydrofuran	ND	970	39	ug/kg	
108-88-3	Toluene	ND	490	16	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	490	67	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	490	39	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	190	16	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	190	28	ug/kg	
79-01-6	Trichloroethene	319	190	25	ug/kg	
75-69-4	Trichlorofluoromethane	ND	190	14	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	490	60	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	490	19	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	490	20	ug/kg	
75-01-4	Vinyl chloride	ND	190	20	ug/kg	
	m,p-Xylene	ND	190	28	ug/kg	
95-47-6	o-Xylene	ND	190	17	ug/kg	
1330-20-7	Xylene (total)	ND	190	17	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID:	045162-95RFRANK-EASTSILT	Date Sampled:	12/14/07
Lab Sample ID:	M69764-1	Date Received:	12/17/07
Matrix:	SO - Soil	Percent Solids:	85.4
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	95%		60-150%
2037-26-5	Toluene-D8	95%		73-125%
460-00-4	4-Bromofluorobenzene	98%		70-141%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID: 045162-95RFRANK-EASTSILT
 Lab Sample ID: M69764-1
 Matrix: SO - Soil
 Method: SW846 8270C SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 85.4

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	I50735.D	1	12/21/07	AT	12/18/07	OP14922	MSI1587
Run #2							

Run #	Initial Weight	Final Volume
Run #1	20.8 g	1.0 ml
Run #2		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
65-85-0	Benzoic acid	ND	560	18	ug/kg	
95-57-8	2-Chlorophenol	ND	280	17	ug/kg	
59-50-7	4-Chloro-3-methyl phenol	ND	560	14	ug/kg	
120-83-2	2,4-Dichlorophenol	ND	560	34	ug/kg	
105-67-9	2,4-Dimethylphenol	ND	560	87	ug/kg	
51-28-5	2,4-Dinitrophenol	ND	1100	49	ug/kg	
95-48-7	2-Methylphenol	ND	560	17	ug/kg	
	3&4-Methylphenol	ND	560	21	ug/kg	
88-75-5	2-Nitrophenol	ND	560	7.2	ug/kg	
100-02-7	4-Nitrophenol	ND	1100	110	ug/kg	
87-86-5	Pentachlorophenol	ND	560	270	ug/kg	
108-95-2	Phenol	ND	280	280	ug/kg	
95-95-4	2,4,5-Trichlorophenol	ND	560	18	ug/kg	
88-06-2	2,4,6-Trichlorophenol	ND	560	8.5	ug/kg	
83-32-9	Acenaphthene	ND	280	11	ug/kg	
208-96-8	Acenaphthylene	59.2	280	7.1	ug/kg	J
98-86-2	Acetophenone	ND	560	7.4	ug/kg	
62-53-3	Aniline	ND	560	36	ug/kg	
120-12-7	Anthracene	103	280	6.3	ug/kg	J
56-55-3	Benzo(a)anthracene	245	280	7.8	ug/kg	J
50-32-8	Benzo(a)pyrene	283	280	33	ug/kg	
205-99-2	Benzo(b)fluoranthene	617	280	9.9	ug/kg	
191-24-2	Benzo(g,h,i)perylene	384	280	11	ug/kg	
207-08-9	Benzo(k)fluoranthene	290	280	8.6	ug/kg	
101-55-3	4-Bromophenyl phenyl ether	ND	280	12	ug/kg	
85-68-7	Butyl benzyl phthalate	ND	280	9.2	ug/kg	
91-58-7	2-Chloronaphthalene	ND	280	7.6	ug/kg	
106-47-8	4-Chloroaniline	ND	560	24	ug/kg	
218-01-9	Chrysene	274	280	8.8	ug/kg	J
111-91-1	bis(2-Chloroethoxy)methane	ND	280	12	ug/kg	
111-44-4	bis(2-Chloroethyl)ether	ND	280	12	ug/kg	
108-60-1	bis(2-Chloroisopropyl)ether	ND	280	6.3	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID:	045162-95RFRANK-EASTSILT		
Lab Sample ID:	M69764-1	Date Sampled:	12/14/07
Matrix:	SO - Soil	Date Received:	12/17/07
Method:	SW846 8270C SW846 3545	Percent Solids:	85.4
Project:	GEI Tufts Street Somerville MA		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
95-50-1	1,2-Dichlorobenzene	ND	280	12	ug/kg	
122-66-7	1,2-Diphenylhydrazine	ND	280	4.4	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	280	10	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	280	12	ug/kg	
121-14-2	2,4-Dinitrotoluene	ND	560	7.6	ug/kg	
606-20-2	2,6-Dinitrotoluene	ND	560	14	ug/kg	
91-94-1	3,3'-Dichlorobenzidine	ND	280	39	ug/kg	
53-70-3	Dibenzo(a,h)anthracene	230	280	13	ug/kg	J
132-64-9	Dibenzofuran	38.8	280	9.7	ug/kg	J
84-74-2	Di-n-butyl phthalate	ND	280	11	ug/kg	
117-84-0	Di-n-octyl phthalate	ND	280	29	ug/kg	
84-66-2	Diethyl phthalate	ND	280	8.8	ug/kg	
131-11-3	Dimethyl phthalate	ND	280	6.5	ug/kg	
117-81-7	bis(2-Ethylhexyl)phthalate	225	280	21	ug/kg	J
206-44-0	Fluoranthene	622	280	11	ug/kg	
86-73-7	Fluorene	ND	280	9.0	ug/kg	
118-74-1	Hexachlorobenzene	ND	280	9.6	ug/kg	
87-68-3	Hexachlorobutadiene	ND	280	16	ug/kg	
77-47-4	Hexachlorocyclopentadiene	ND	560	13	ug/kg	
67-72-1	Hexachloroethane	ND	280	10	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	361	280	18	ug/kg	
78-59-1	Isophorone	ND	280	11	ug/kg	
91-57-6	2-Methylnaphthalene	88.8	280	9.8	ug/kg	J
91-20-3	Naphthalene	612	280	12	ug/kg	
98-95-3	Nitrobenzene	ND	280	15	ug/kg	
621-64-7	N-Nitroso-di-n-propylamine	ND	280	14	ug/kg	
86-30-6	N-Nitrosodiphenylamine	ND	280	6.0	ug/kg	
85-01-8	Phenanthrene	469	280	4.4	ug/kg	
129-00-0	Pyrene	469	280	4.0	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	280	9.5	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
367-12-4	2-Fluorophenol	76%		20-120%
4165-62-2	Phenol-d5	77%		23-120%
118-79-6	2,4,6-Tribromophenol	102%		10-120%
4165-60-0	Nitrobenzene-d5	67%		20-118%
321-60-8	2-Fluorobiphenyl	82%		30-115%
1718-51-0	Terphenyl-d14	73%		32-126%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID: 045162-95RFRANK-EASTSILT	
Lab Sample ID: M69764-1	Date Sampled: 12/14/07
Matrix: SO - Soil	Date Received: 12/17/07
Method: MADEP EPH REV 1.1 SW846 3545	Percent Solids: 85.4
Project: GEI Tufts Street Somerville MA	

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	PO52465.D	1	12/20/07	SL	12/18/07	OP14923	GPO3094
Run #2							

	Initial Weight	Final Volume
Run #1	10.9 g	2.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
83-32-9	Acenaphthene	ND	540	430	ug/kg	
208-96-8	Acenaphthylene	ND	540	430	ug/kg	
120-12-7	Anthracene	ND	540	430	ug/kg	
56-55-3	Benzo(a)anthracene	ND	540	430	ug/kg	
50-32-8	Benzo(a)pyrene	ND	540	430	ug/kg	
205-99-2	Benzo(b)fluoranthene	ND	540	430	ug/kg	
191-24-2	Benzo(g,h,i)perylene	630	540	430	ug/kg	
207-08-9	Benzo(k)fluoranthene	ND	540	430	ug/kg	
218-01-9	Chrysene	ND	540	430	ug/kg	
53-70-3	Dibenz(a,h)anthracene	ND	540	430	ug/kg	
206-44-0	Fluoranthene	442	540	430	ug/kg	J
86-73-7	Fluorene	ND	540	430	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	ND	540	430	ug/kg	
91-57-6	2-Methylnaphthalene	ND	540	430	ug/kg	
91-20-3	Naphthalene	ND	540	430	ug/kg	
85-01-8	Phenanthrene	ND	540	430	ug/kg	
129-00-0	Pyrene	449	540	430	ug/kg	J
	C11-C22 Aromatics (Unadj.)	24100	22000	18000	ug/kg	
	C9-C18 Aliphatics	9940	11000	8600	ug/kg	J
	C19-C36 Aliphatics	ND	11000	8600	ug/kg	
	C11-C22 Aromatics	20500	22000	18000	ug/kg	J

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
84-15-1	o-Terphenyl	93%		40-140%
321-60-8	2-Fluorobiphenyl	80%		40-140%
580-13-2	2-Bromonaphthalene	85%		40-140%
3386-33-2	1-Chlorooctadecane	46%		40-140%

ND = Not detected MDL - Method Detection Limit
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J = Indicates an estimated value
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 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.1

Client Sample ID: 045162-95RFRANK-EASTSILT
 Lab Sample ID: M69764-1
 Matrix: SO - Soil
 Method: SW846 8082 SW846 3510C
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 85.4

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	EF59202.D	1	12/24/07	SL	12/20/07	OP14931	GEF2829
Run #2							

	Initial Weight	Final Volume
Run #1	15.5 g	10.0 ml
Run #2		

PCB List

CAS No.	Compound	Result	RL	MDL	Units	Q
12674-11-2	Aroclor 1016	ND	110	16	ug/kg	
11104-28-2	Aroclor 1221	ND	110	5.7	ug/kg	
11141-16-5	Aroclor 1232	ND	110	13	ug/kg	
53469-21-9	Aroclor 1242	ND	110	9.3	ug/kg	
12672-29-6	Aroclor 1248	ND	110	7.6	ug/kg	
11097-69-1	Aroclor 1254	ND	110	6.9	ug/kg	
11096-82-5	Aroclor 1260	ND	110	12	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	84%		30-140%
877-09-8	Tetrachloro-m-xylene	92%		30-140%
2051-24-3	Decachlorobiphenyl	99%		30-150%
2051-24-3	Decachlorobiphenyl	117%		30-150%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
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J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Page 1 of 1

3.1

Client Sample ID: 045162-95RFRANK-EASTSILT

Lab Sample ID: M69764-1

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07

Date Received: 12/17/07

Percent Solids: 85.4

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Arsenic	10.9	2.3	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Cadmium	< 0.46	0.46	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Chromium	22.8	1.1	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Lead	499	2.3	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Mercury	0.26	0.036	mg/kg	1	12/18/07	12/19/07 MA	SW846 7471A ¹	SW846 7471A ³

(1) Instrument QC Batch: MA8807

(2) Instrument QC Batch: MA8818

(3) Prep QC Batch: MP11293

(4) Prep QC Batch: MP11300

RL = Reporting Limit

Report of Analysis

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3.1

Client Sample ID: 045162-95RFRANK-EASTSILT	Date Sampled: 12/14/07
Lab Sample ID: M69764-1	Date Received: 12/17/07
Matrix: SO - Soil	Percent Solids: 85.4
Project: GEI Tufts Street Somerville MA	

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Corrosivity as pH	6.5			1	12/18/07	MA	SW846 CHAP7
Cyanide Reactivity	< 1.8	1.8	mg/kg	1	12/19/07	BF	SW846 CHAP7
Ignitability (Flashpoint)	> 230		Deg. F	1	12/22/07	MA	SW846 1020
Solids, Percent	85.4		%	1	12/18/07	CF	SM21 2540 B MOD.
Specific Conductivity	1220	0.50	umhos/cm	1	12/18/07	MA	EPA 120.1M
Sulfide Reactivity	< 59	59	mg/kg	1	12/19/07	BF	SW846 CHAP7
Total Organic Carbon	20300	1100	mg/kg	1	12/20/07 14:40	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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3.2

Client Sample ID: 045162-95RFRANK-EASTFILL

Lab Sample ID: M69764-2

Date Sampled: 12/14/07

Matrix: SO - Soil

Date Received: 12/17/07

Method: SW846 8260B

Percent Solids: 81.0

Project: GEI Tufts Street Somerville MA

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H43974.D	1	12/18/07	PB	n/a	n/a	MSH1362
Run #2	H43997.D	1	12/19/07	PB	n/a	n/a	MSH1362

	Initial Weight	Final Volume	Methanol Aliquot
Run #1	6.84 g	10.0 ml	100 ul
Run #2	6.84 g	10.0 ml	20.0 ul

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	510	330	ug/kg	
71-43-2	Benzene	ND	51	18	ug/kg	
108-86-1	Bromobenzene	ND	510	38	ug/kg	
74-97-5	Bromochloromethane	ND	510	97	ug/kg	
75-27-4	Bromodichloromethane	ND	200	19	ug/kg	
75-25-2	Bromoform	ND	200	38	ug/kg	
74-83-9	Bromomethane	ND	200	46	ug/kg	
78-93-3	2-Butanone (MEK)	ND	510	140	ug/kg	
104-51-8	n-Butylbenzene	ND	510	21	ug/kg	
135-98-8	sec-Butylbenzene	ND	510	15	ug/kg	
98-06-6	tert-Butylbenzene	ND	510	20	ug/kg	
75-15-0	Carbon disulfide	ND	510	49	ug/kg	
56-23-5	Carbon tetrachloride	ND	200	16	ug/kg	
108-90-7	Chlorobenzene	ND	200	16	ug/kg	
75-00-3	Chloroethane	ND	510	26	ug/kg	
67-66-3	Chloroform	ND	200	63	ug/kg	
74-87-3	Chloromethane	ND	510	31	ug/kg	
95-49-8	o-Chlorotoluene	ND	510	18	ug/kg	
106-43-4	p-Chlorotoluene	ND	510	34	ug/kg	
108-20-3	Di-Isopropyl ether	ND	200	14	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	510	170	ug/kg	
124-48-1	Dibromochloromethane	ND	200	29	ug/kg	
106-93-4	1,2-Dibromoethane	ND	200	27	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	200	18	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	200	36	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	200	44	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	200	12	ug/kg	
75-34-3	1,1-Dichloroethane	430	200	27	ug/kg	
107-06-2	1,2-Dichloroethane	ND	200	13	ug/kg	
75-35-4	1,1-Dichloroethene	106	200	33	ug/kg	J
156-59-2	cis-1,2-Dichloroethene	96.9	200	27	ug/kg	J
156-60-5	trans-1,2-Dichloroethene	ND	200	35	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID:	045162-95RFRANK-EASTFILL	Date Sampled:	12/14/07
Lab Sample ID:	M69764-2	Date Received:	12/17/07
Matrix:	SO - Soil	Percent Solids:	81.0
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	200	23	ug/kg	
142-28-9	1,3-Dichloropropane	ND	510	100	ug/kg	
594-20-7	2,2-Dichloropropane	ND	510	22	ug/kg	
563-58-6	1,1-Dichloropropene	ND	510	19	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	200	18	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	200	16	ug/kg	
123-91-1	1,4-Dioxane	ND	2500	1600	ug/kg	
60-29-7	Ethyl Ether	ND	510	43	ug/kg	
100-41-4	Ethylbenzene	ND	200	16	ug/kg	
87-68-3	Hexachlorobutadiene	ND	510	51	ug/kg	
591-78-6	2-Hexanone	ND	510	160	ug/kg	
98-82-8	Isopropylbenzene	ND	510	15	ug/kg	
99-87-6	p-Isopropyltoluene	ND	510	21	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	200	68	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	510	67	ug/kg	
74-95-3	Methylene bromide	ND	510	54	ug/kg	
75-09-2	Methylene chloride	ND	200	50	ug/kg	
91-20-3	Naphthalene	ND	510	38	ug/kg	
103-65-1	n-Propylbenzene	ND	510	10	ug/kg	
100-42-5	Styrene	ND	510	61	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	510	42	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	200	18	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	510	26	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	200	40	ug/kg	
127-18-4	Tetrachloroethene	46200 a	1000	120	ug/kg	
109-99-9	Tetrahydrofuran	ND	1000	41	ug/kg	
108-88-3	Toluene	ND	510	17	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	510	70	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	510	41	ug/kg	
71-55-6	1,1,1-Trichloroethane	47.6	200	17	ug/kg	J
79-00-5	1,1,2-Trichloroethane	ND	200	29	ug/kg	
79-01-6	Trichloroethene	2160	200	27	ug/kg	
75-69-4	Trichlorofluoromethane	ND	200	15	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	510	63	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	510	20	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	510	21	ug/kg	
75-01-4	Vinyl chloride	ND	200	22	ug/kg	
	m,p-Xylene	ND	200	29	ug/kg	
95-47-6	o-Xylene	ND	200	18	ug/kg	
1330-20-7	Xylene (total)	ND	200	18	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
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J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.2

Client Sample ID:	045162-95RFRANK-EASTFILL	Date Sampled:	12/14/07
Lab Sample ID:	M69764-2	Date Received:	12/17/07
Matrix:	SO - Soil	Percent Solids:	81.0
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	101%	110%	60-150%
2037-26-5	Toluene-D8	98%	100%	73-125%
460-00-4	4-Bromofluorobenzene	100%	102%	70-141%

(a) Result is from Run# 2

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-EASTFILL
 Lab Sample ID: M69764-2
 Matrix: SO - Soil
 Method: SW846 8270C SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 81.0

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	I50736.D	1	12/21/07	AT	12/18/07	OP14922	MSI1587
Run #2							

Run #	Initial Weight	Final Volume
Run #1	20.8 g	1.0 ml
Run #2		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
65-85-0	Benzoic acid	ND	590	19	ug/kg	
95-57-8	2-Chlorophenol	ND	300	18	ug/kg	
59-50-7	4-Chloro-3-methyl phenol	ND	590	15	ug/kg	
120-83-2	2,4-Dichlorophenol	ND	590	36	ug/kg	
105-67-9	2,4-Dimethylphenol	ND	590	91	ug/kg	
51-28-5	2,4-Dinitrophenol	ND	1200	51	ug/kg	
95-48-7	2-Methylphenol	ND	590	18	ug/kg	
	3&4-Methylphenol	ND	590	22	ug/kg	
88-75-5	2-Nitrophenol	ND	590	7.6	ug/kg	
100-02-7	4-Nitrophenol	ND	1200	120	ug/kg	
87-86-5	Pentachlorophenol	ND	590	280	ug/kg	
108-95-2	Phenol	ND	300	300	ug/kg	
95-95-4	2,4,5-Trichlorophenol	ND	590	19	ug/kg	
88-06-2	2,4,6-Trichlorophenol	ND	590	9.0	ug/kg	
83-32-9	Acenaphthene	257	300	12	ug/kg	J
208-96-8	Acenaphthylene	636	300	7.5	ug/kg	
98-86-2	Acetophenone	ND	590	7.8	ug/kg	
62-53-3	Aniline	ND	590	38	ug/kg	
120-12-7	Anthracene	764	300	6.6	ug/kg	
56-55-3	Benzo(a)anthracene	1650	300	8.2	ug/kg	
50-32-8	Benzo(a)pyrene	1730	300	35	ug/kg	
205-99-2	Benzo(b)fluoranthene	1790	300	10	ug/kg	
191-24-2	Benzo(g,h,i)perylene	876	300	12	ug/kg	
207-08-9	Benzo(k)fluoranthene	1440	300	9.1	ug/kg	
101-55-3	4-Bromophenyl phenyl ether	ND	300	13	ug/kg	
85-68-7	Butyl benzyl phthalate	ND	300	9.7	ug/kg	
91-58-7	2-Chloronaphthalene	ND	300	8.0	ug/kg	
106-47-8	4-Chloroaniline	ND	590	25	ug/kg	
218-01-9	Chrysene	1840	300	9.3	ug/kg	
111-91-1	bis(2-Chloroethoxy)methane	ND	300	13	ug/kg	
111-44-4	bis(2-Chloroethyl)ether	ND	300	12	ug/kg	
108-60-1	bis(2-Chloroisopropyl)ether	ND	300	6.6	ug/kg	

ND = Not detected MDL - Method Detection Limit
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 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.2

3

Client Sample ID: 045162-95RFRANK-EASTFILL
 Lab Sample ID: M69764-2
 Matrix: SO - Soil
 Method: SW846 8270C SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 81.0

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
95-50-1	1,2-Dichlorobenzene	ND	300	13	ug/kg	
122-66-7	1,2-Diphenylhydrazine	ND	300	4.6	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	300	11	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	300	13	ug/kg	
121-14-2	2,4-Dinitrotoluene	ND	590	8.0	ug/kg	
606-20-2	2,6-Dinitrotoluene	ND	590	15	ug/kg	
91-94-1	3,3'-Dichlorobenzidine	ND	300	41	ug/kg	
53-70-3	Dibenzo(a,h)anthracene	479	300	13	ug/kg	
132-64-9	Dibenzofuran	424	300	10	ug/kg	
84-74-2	Di-n-butyl phthalate	80.1	300	12	ug/kg	J
117-84-0	Di-n-octyl phthalate	ND	300	31	ug/kg	
84-66-2	Diethyl phthalate	ND	300	9.3	ug/kg	
131-11-3	Dimethyl phthalate	ND	300	6.8	ug/kg	
117-81-7	bis(2-Ethylhexyl)phthalate	ND	300	22	ug/kg	
206-44-0	Fluoranthene	3640	300	12	ug/kg	
86-73-7	Fluorene	450	300	9.5	ug/kg	
118-74-1	Hexachlorobenzene	ND	300	10	ug/kg	
87-68-3	Hexachlorobutadiene	ND	300	17	ug/kg	
77-47-4	Hexachlorocyclopentadiene	ND	590	14	ug/kg	
67-72-1	Hexachloroethane	ND	300	11	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	1070	300	19	ug/kg	
78-59-1	Isophorone	ND	300	11	ug/kg	
91-57-6	2-Methylnaphthalene	1180	300	10	ug/kg	
91-20-3	Naphthalene	5300	300	12	ug/kg	
98-95-3	Nitrobenzene	ND	300	16	ug/kg	
621-64-7	N-Nitroso-di-n-propylamine	ND	300	15	ug/kg	
86-30-6	N-Nitrosodiphenylamine	ND	300	6.3	ug/kg	
85-01-8	Phenanthrene	3020	300	4.6	ug/kg	
129-00-0	Pyrene	2770	300	4.2	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	300	10	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
367-12-4	2-Fluorophenol	72%		20-120%
4165-62-2	Phenol-d5	79%		23-120%
118-79-6	2,4,6-Tribromophenol	107%		10-120%
4165-60-0	Nitrobenzene-d5	72%		20-118%
321-60-8	2-Fluorobiphenyl	84%		30-115%
1718-51-0	Terphenyl-d14	75%		32-126%

ND = Not detected MDL - Method Detection Limit
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 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Page 1 of 1

Client Sample ID: 045162-95RFRANK-EASTFILL
 Lab Sample ID: M69764-2
 Matrix: SO - Soil
 Method: MADEP EPH REV 1.1 SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 81.0

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	PO52467.D	1	12/20/07	SL	12/18/07	OP14923	GPO3094
Run #2							

	Initial Weight	Final Volume
Run #1	11.0 g	2.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
83-32-9	Acenaphthene	ND	560	450	ug/kg	
208-96-8	Acenaphthylene	ND	560	450	ug/kg	
120-12-7	Anthracene	669	560	450	ug/kg	
56-55-3	Benzo(a)anthracene	1250	560	450	ug/kg	
50-32-8	Benzo(a)pyrene	2080	560	450	ug/kg	
205-99-2	Benzo(b)fluoranthene	2060	560	450	ug/kg	
191-24-2	Benzo(g,h,i)perylene	2450	560	450	ug/kg	
207-08-9	Benzo(k)fluoranthene	1740	560	450	ug/kg	
218-01-9	Chrysene	1680	560	450	ug/kg	
53-70-3	Dibenz(a,h)anthracene	460	560	450	ug/kg	J
206-44-0	Fluoranthene	3120	560	450	ug/kg	
86-73-7	Fluorene	ND	560	450	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	2080	560	450	ug/kg	
91-57-6	2-Methylnaphthalene	ND	560	450	ug/kg	
91-20-3	Naphthalene	ND	560	450	ug/kg	
85-01-8	Phenanthrene	2830	560	450	ug/kg	
129-00-0	Pyrene	2850	560	450	ug/kg	
	C11-C22 Aromatics (Unadj.)	148000	23000	19000	ug/kg	
	C9-C18 Aliphatics	31300	11000	9000	ug/kg	
	C19-C36 Aliphatics	52300	11000	9000	ug/kg	
	C11-C22 Aromatics	123000	23000	19000	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
84-15-1	o-Terphenyl	115%		40-140%
321-60-8	2-Fluorobiphenyl	69%		40-140%
580-13-2	2-Bromonaphthalene	84%		40-140%
3386-33-2	1-Chlorooctadecane	46%		40-140%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-EASTFILL
 Lab Sample ID: M69764-2
 Matrix: SO - Soil
 Method: SW846 8082 SW846 3510C
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 81.0

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	EF59203.D	1	12/24/07	SL	12/20/07	OP14931	GEF2829
Run #2							

Run #	Initial Weight	Final Volume
Run #1	15.4 g	10.0 ml
Run #2		

PCB List

CAS No.	Compound	Result	RL	MDL	Units	Q
12674-11-2	Aroclor 1016	ND	120	17	ug/kg	
11104-28-2	Aroclor 1221	ND	120	6.1	ug/kg	
11141-16-5	Aroclor 1232	ND	120	14	ug/kg	
53469-21-9	Aroclor 1242	ND	120	9.9	ug/kg	
12672-29-6	Aroclor 1248	ND	120	8.1	ug/kg	
11097-69-1	Aroclor 1254	ND	120	7.3	ug/kg	
11096-82-5	Aroclor 1260	ND	120	12	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	61%		30-140%
877-09-8	Tetrachloro-m-xylene	65%		30-140%
2051-24-3	Decachlorobiphenyl	103%		30-150%
2051-24-3	Decachlorobiphenyl	135%		30-150%

ND = Not detected MDL - Method Detection Limit
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 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-EASTFILL
Lab Sample ID: M69764-2
Matrix: SO - Soil
Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
Date Received: 12/17/07
Percent Solids: 81.0

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Arsenic	31.5	2.3	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁵
Cadmium	1.5	0.46	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁵
Chromium	25.1	1.1	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁵
Lead	4870	23	mg/kg	10	12/19/07	12/21/07 PY	SW846 6010B ³	SW846 3050B ⁵
Mercury	3.0	0.41	mg/kg	10	12/18/07	12/19/07 MA	SW846 7471A ¹	SW846 7471A ⁴

- (1) Instrument QC Batch: MA8807
(2) Instrument QC Batch: MA8818
(3) Instrument QC Batch: MA8824
(4) Prep QC Batch: MP11293
(5) Prep QC Batch: MP11300

RL = Reporting Limit

Report of Analysis

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3.2

Client Sample ID: 045162-95RFRANK-EASTFILL

Lab Sample ID: M69764-2

Date Sampled: 12/14/07

Matrix: SO - Soil

Date Received: 12/17/07

Percent Solids: 81.0

Project: GEI Tufts Street Somerville MA

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Corrosivity as pH	8.7			1	12/18/07	MA	SW846 CHAP7
Cyanide Reactivity	< 1.9	1.9	mg/kg	1	12/19/07	BF	SW846 CHAP7
Ignitability (Flashpoint)	> 230		Deg. F	1	12/22/07	MA	SW846 1020
Solids, Percent	81		%	1	12/18/07	CF	SM21 2540 B MOD.
Specific Conductivity	2770	0.50	umhos/cm	1	12/18/07	MA	EPA 120.1M
Sulfide Reactivity	< 62	62	mg/kg	1	12/19/07	BF	SW846 CHAP7
Total Organic Carbon	219000	11000	mg/kg	1	12/20/07 18:37	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT
 Lab Sample ID: M69764-3
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 84.1

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H43976.D	1	12/18/07	PB	n/a	n/a	MSH1362
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	8.63 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	390	260	ug/kg	
71-43-2	Benzene	ND	39	14	ug/kg	
108-86-1	Bromobenzene	ND	390	29	ug/kg	
74-97-5	Bromochloromethane	ND	390	75	ug/kg	
75-27-4	Bromodichloromethane	ND	160	15	ug/kg	
75-25-2	Bromoform	ND	160	29	ug/kg	
74-83-9	Bromomethane	ND	160	35	ug/kg	
78-93-3	2-Butanone (MEK)	ND	390	110	ug/kg	
104-51-8	n-Butylbenzene	ND	390	16	ug/kg	
135-98-8	sec-Butylbenzene	ND	390	11	ug/kg	
98-06-6	tert-Butylbenzene	ND	390	15	ug/kg	
75-15-0	Carbon disulfide	ND	390	38	ug/kg	
56-23-5	Carbon tetrachloride	ND	160	12	ug/kg	
108-90-7	Chlorobenzene	ND	160	12	ug/kg	
75-00-3	Chloroethane	ND	390	20	ug/kg	
67-66-3	Chloroform	ND	160	48	ug/kg	
74-87-3	Chloromethane	ND	390	24	ug/kg	
95-49-8	o-Chlorotoluene	ND	390	14	ug/kg	
106-43-4	p-Chlorotoluene	ND	390	26	ug/kg	
108-20-3	Di-Isopropyl ether	ND	160	11	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	390	130	ug/kg	
124-48-1	Dibromochloromethane	ND	160	22	ug/kg	
106-93-4	1,2-Dibromoethane	ND	160	21	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	160	14	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	160	28	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	160	34	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	160	9.6	ug/kg	
75-34-3	1,1-Dichloroethane	ND	160	21	ug/kg	
107-06-2	1,2-Dichloroethane	ND	160	10	ug/kg	
75-35-4	1,1-Dichloroethene	ND	160	25	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	160	21	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	160	27	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT
 Lab Sample ID: M69764-3
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 84.1

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	160	18	ug/kg	
142-28-9	1,3-Dichloropropane	ND	390	77	ug/kg	
594-20-7	2,2-Dichloropropane	ND	390	17	ug/kg	
563-58-6	1,1-Dichloropropene	ND	390	14	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	160	14	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	160	12	ug/kg	
123-91-1	1,4-Dioxane	ND	2000	1300	ug/kg	
60-29-7	Ethyl Ether	ND	390	33	ug/kg	
100-41-4	Ethylbenzene	ND	160	12	ug/kg	
87-68-3	Hexachlorobutadiene	ND	390	39	ug/kg	
591-78-6	2-Hexanone	ND	390	120	ug/kg	
98-82-8	Isopropylbenzene	ND	390	12	ug/kg	
99-87-6	p-Isopropyltoluene	ND	390	16	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	160	52	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	390	52	ug/kg	
74-95-3	Methylene bromide	ND	390	41	ug/kg	
75-09-2	Methylene chloride	ND	160	38	ug/kg	
91-20-3	Naphthalene	ND	390	29	ug/kg	
103-65-1	n-Propylbenzene	ND	390	7.9	ug/kg	
100-42-5	Styrene	ND	390	47	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	390	32	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	160	14	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	390	20	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	160	31	ug/kg	
127-18-4	Tetrachloroethene	ND	160	18	ug/kg	
109-99-9	Tetrahydrofuran	ND	780	31	ug/kg	
108-88-3	Toluene	ND	390	13	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	390	54	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	390	31	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	160	13	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	160	22	ug/kg	
79-01-6	Trichloroethene	ND	160	20	ug/kg	
75-69-4	Trichlorofluoromethane	ND	160	12	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	390	49	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	390	16	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	390	16	ug/kg	
75-01-4	Vinyl chloride	ND	160	17	ug/kg	
	m,p-Xylene	ND	160	22	ug/kg	
95-47-6	o-Xylene	ND	160	14	ug/kg	
1330-20-7	Xylene (total)	ND	160	14	ug/kg	

ND = Not detected MDL - Method Detection Limit
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J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID:	045162-95RFRANK-WESTSILT	Date Sampled:	12/14/07
Lab Sample ID:	M69764-3	Date Received:	12/17/07
Matrix:	SO - Soil	Percent Solids:	84.1
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	100%		60-150%
2037-26-5	Toluene-D8	98%		73-125%
460-00-4	4-Bromofluorobenzene	101%		70-141%

ND = Not detected MDL - Method Detection Limit
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J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT
 Lab Sample ID: M69764-3
 Matrix: SO - Soil
 Method: SW846 8270C SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 84.1

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	I50737.D	1	12/21/07	AT	12/18/07	OP14922	MSI1587
Run #2							

Run #	Initial Weight	Final Volume
Run #1	20.3 g	1.0 ml
Run #2		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
65-85-0	Benzoic acid	ND	590	18	ug/kg	
95-57-8	2-Chlorophenol	ND	290	17	ug/kg	
59-50-7	4-Chloro-3-methyl phenol	ND	590	15	ug/kg	
120-83-2	2,4-Dichlorophenol	ND	590	35	ug/kg	
105-67-9	2,4-Dimethylphenol	ND	590	90	ug/kg	
51-28-5	2,4-Dinitrophenol	ND	1200	51	ug/kg	
95-48-7	2-Methylphenol	ND	590	18	ug/kg	
	3&4-Methylphenol	ND	590	22	ug/kg	
88-75-5	2-Nitrophenol	ND	590	7.5	ug/kg	
100-02-7	4-Nitrophenol	ND	1200	110	ug/kg	
87-86-5	Pentachlorophenol	ND	590	280	ug/kg	
108-95-2	Phenol	ND	290	290	ug/kg	
95-95-4	2,4,5-Trichlorophenol	ND	590	19	ug/kg	
88-06-2	2,4,6-Trichlorophenol	ND	590	8.9	ug/kg	
83-32-9	Acenaphthene	30.8	290	12	ug/kg	J
208-96-8	Acenaphthylene	368	290	7.4	ug/kg	
98-86-2	Acetophenone	ND	590	7.7	ug/kg	
62-53-3	Aniline	ND	590	38	ug/kg	
120-12-7	Anthracene	39.8	290	6.6	ug/kg	J
56-55-3	Benzo(a)anthracene	52.6	290	8.1	ug/kg	J
50-32-8	Benzo(a)pyrene	ND	290	34	ug/kg	
205-99-2	Benzo(b)fluoranthene	ND	290	10	ug/kg	
191-24-2	Benzo(g,h,i)perylene	ND	290	11	ug/kg	
207-08-9	Benzo(k)fluoranthene	ND	290	9.0	ug/kg	
101-55-3	4-Bromophenyl phenyl ether	ND	290	13	ug/kg	
85-68-7	Butyl benzyl phthalate	ND	290	9.6	ug/kg	
91-58-7	2-Chloronaphthalene	ND	290	7.9	ug/kg	
106-47-8	4-Chloroaniline	ND	590	25	ug/kg	
218-01-9	Chrysene	46.8	290	9.1	ug/kg	J
111-91-1	bis(2-Chloroethoxy)methane	ND	290	13	ug/kg	
111-44-4	bis(2-Chloroethyl)ether	ND	290	12	ug/kg	
108-60-1	bis(2-Chloroisopropyl)ether	ND	290	6.6	ug/kg	

ND = Not detected MDL - Method Detection Limit
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 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	045162-95RFRANK-WESTSILT		
Lab Sample ID:	M69764-3	Date Sampled:	12/14/07
Matrix:	SO - Soil	Date Received:	12/17/07
Method:	SW846 8270C SW846 3545	Percent Solids:	84.1
Project:	GEI Tufts Street Somerville MA		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
95-50-1	1,2-Dichlorobenzene	ND	290	13	ug/kg	
122-66-7	1,2-Diphenylhydrazine	ND	290	4.6	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	290	11	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	290	13	ug/kg	
121-14-2	2,4-Dinitrotoluene	ND	590	7.9	ug/kg	
606-20-2	2,6-Dinitrotoluene	ND	590	15	ug/kg	
91-94-1	3,3'-Dichlorobenzidine	ND	290	41	ug/kg	
53-70-3	Dibenzo(a,h)anthracene	ND	290	13	ug/kg	
132-64-9	Dibenzofuran	187	290	10	ug/kg	J
84-74-2	Di-n-butyl phthalate	ND	290	11	ug/kg	
117-84-0	Di-n-octyl phthalate	ND	290	30	ug/kg	
84-66-2	Diethyl phthalate	ND	290	9.2	ug/kg	
131-11-3	Dimethyl phthalate	ND	290	6.7	ug/kg	
117-81-7	bis(2-Ethylhexyl)phthalate	194	290	22	ug/kg	J
206-44-0	Fluoranthene	135	290	12	ug/kg	J
86-73-7	Fluorene	167	290	9.4	ug/kg	J
118-74-1	Hexachlorobenzene	ND	290	10	ug/kg	
87-68-3	Hexachlorobutadiene	ND	290	17	ug/kg	
77-47-4	Hexachlorocyclopentadiene	ND	590	14	ug/kg	
67-72-1	Hexachloroethane	ND	290	11	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	ND	290	19	ug/kg	
78-59-1	Isophorone	ND	290	11	ug/kg	
91-57-6	2-Methylnaphthalene	755	290	10	ug/kg	
91-20-3	Naphthalene	5130	290	12	ug/kg	
98-95-3	Nitrobenzene	ND	290	16	ug/kg	
621-64-7	N-Nitroso-di-n-propylamine	ND	290	15	ug/kg	
86-30-6	N-Nitrosodiphenylamine	ND	290	6.3	ug/kg	
85-01-8	Phenanthrene	220	290	4.6	ug/kg	J
129-00-0	Pyrene	93.2	290	4.1	ug/kg	J
120-82-1	1,2,4-Trichlorobenzene	ND	290	9.9	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
367-12-4	2-Fluorophenol	71%		20-120%
4165-62-2	Phenol-d5	77%		23-120%
118-79-6	2,4,6-Tribromophenol	97%		10-120%
4165-60-0	Nitrobenzene-d5	69%		20-118%
321-60-8	2-Fluorobiphenyl	86%		30-115%
1718-51-0	Terphenyl-d14	75%		32-126%

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 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT

Lab Sample ID: M69764-3

Date Sampled: 12/14/07

Matrix: SO - Soil

Date Received: 12/17/07

Method: MADEP EPH REV 1.1 SW846 3545

Percent Solids: 84.1

Project: GEI Tufts Street Somerville MA

Run #1	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #2	PO52472.D	1	12/21/07	SL	12/18/07	OP14923	GPO3095

Run #1	Initial Weight	Final Volume
Run #2	10.8 g	2.0 ml

CAS No.	Compound	Result	RL	MDL	Units	Q
83-32-9	Acenaphthene	ND	550	440	ug/kg	
208-96-8	Acenaphthylene	ND	550	440	ug/kg	
120-12-7	Anthracene	ND	550	440	ug/kg	
56-55-3	Benzo(a)anthracene	ND	550	440	ug/kg	
50-32-8	Benzo(a)pyrene	ND	550	440	ug/kg	
205-99-2	Benzo(b)fluoranthene	ND	550	440	ug/kg	
191-24-2	Benzo(g,h,i)perylene	ND	550	440	ug/kg	
207-08-9	Benzo(k)fluoranthene	ND	550	440	ug/kg	
218-01-9	Chrysene	ND	550	440	ug/kg	
53-70-3	Dibenz(a,h)anthracene	ND	550	440	ug/kg	
206-44-0	Fluoranthene	ND	550	440	ug/kg	
86-73-7	Fluorene	ND	550	440	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	ND	550	440	ug/kg	
91-57-6	2-Methylnaphthalene	ND	550	440	ug/kg	
91-20-3	Naphthalene	ND	550	440	ug/kg	
85-01-8	Phenanthrene	ND	550	440	ug/kg	
129-00-0	Pyrene	ND	550	440	ug/kg	
	C11-C22 Aromatics (Unadj.)	ND	22000	19000	ug/kg	
	C9-C18 Aliphatics	9560	11000	8800	ug/kg	J
	C19-C36 Aliphatics	ND	11000	8800	ug/kg	
	C11-C22 Aromatics	ND	22000	19000	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
84-15-1	o-Terphenyl	85%		40-140%
321-60-8	2-Fluorobiphenyl	85%		40-140%
580-13-2	2-Bromonaphthalene	88%		40-140%
3386-33-2	1-Chlorooctadecane	47%		40-140%

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT
 Lab Sample ID: M69764-3
 Matrix: SO - Soil
 Method: SW846 8082 SW846 3510C
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 84.1

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	EF59204.D	1	12/24/07	SL	12/20/07	OP14931	GEF2829
Run #2							

	Initial Weight	Final Volume
Run #1	15.8 g	10.0 ml
Run #2		

PCB List

CAS No.	Compound	Result	RL	MDL	Units	Q
12674-11-2	Aroclor 1016	ND	110	16	ug/kg	
11104-28-2	Aroclor 1221	ND	110	5.7	ug/kg	
11141-16-5	Aroclor 1232	ND	110	13	ug/kg	
53469-21-9	Aroclor 1242	ND	110	9.3	ug/kg	
12672-29-6	Aroclor 1248	ND	110	7.6	ug/kg	
11097-69-1	Aroclor 1254	ND	110	6.9	ug/kg	
11096-82-5	Aroclor 1260	ND	110	12	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	72%		30-140%
877-09-8	Tetrachloro-m-xylene	78%		30-140%
2051-24-3	Decachlorobiphenyl	88%		30-150%
2051-24-3	Decachlorobiphenyl	93%		30-150%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT
Lab Sample ID: M69764-3
Matrix: SO - Soil
Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
Date Received: 12/17/07
Percent Solids: 84.1

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Arsenic	12.6	2.2	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁵
Cadmium	< 0.44	0.44	mg/kg	1	12/19/07	12/21/07 PY	SW846 6010B ³	SW846 3050B ⁵
Chromium	32.0	1.1	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁵
Lead	44.2	2.2	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁵
Mercury	0.039	0.038	mg/kg	1	12/18/07	12/19/07 MA	SW846 7471A ¹	SW846 7471A ⁴

- (1) Instrument QC Batch: MA8807
(2) Instrument QC Batch: MA8818
(3) Instrument QC Batch: MA8824
(4) Prep QC Batch: MP11293
(5) Prep QC Batch: MP11300

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTSILT

Lab Sample ID: M69764-3

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07

Date Received: 12/17/07

Percent Solids: 84.1

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Corrosivity as pH	8.0			1	12/18/07	MA	SW846 CHAP7
Cyanide Reactivity	< 1.8	1.8	mg/kg	1	12/19/07	BF	SW846 CHAP7
Ignitability (Flashpoint)	> 230		Deg. F	1	12/22/07	MA	SW846 1020
Solids, Percent	84.1		%	1	12/18/07	CF	SM21 2540 B MOD.
Specific Conductivity	188	0.50	umhos/cm	1	12/18/07	MA	EPA 120.1M
Sulfide Reactivity	< 59	59	mg/kg	1	12/19/07	BF	SW846 CHAP7
Total Organic Carbon	17100	1100	mg/kg	1	12/20/07 16:31	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTFILL
 Lab Sample ID: M69764-4
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 80.3

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	H43977.D	1	12/18/07	PB	n/a	n/a	MSH1362
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	5.73 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	ND	600	400	ug/kg	
71-43-2	Benzene	ND	60	21	ug/kg	
108-86-1	Bromobenzene	ND	600	45	ug/kg	
74-97-5	Bromochloromethane	ND	600	120	ug/kg	
75-27-4	Bromodichloromethane	ND	240	22	ug/kg	
75-25-2	Bromoform	ND	240	45	ug/kg	
74-83-9	Bromomethane	ND	240	55	ug/kg	
78-93-3	2-Butanone (MEK)	ND	600	160	ug/kg	
104-51-8	n-Butylbenzene	ND	600	25	ug/kg	
135-98-8	sec-Butylbenzene	ND	600	18	ug/kg	
98-06-6	tert-Butylbenzene	ND	600	23	ug/kg	
75-15-0	Carbon disulfide	ND	600	59	ug/kg	
56-23-5	Carbon tetrachloride	ND	240	19	ug/kg	
108-90-7	Chlorobenzene	ND	240	19	ug/kg	
75-00-3	Chloroethane	ND	600	31	ug/kg	
67-66-3	Chloroform	ND	240	74	ug/kg	
74-87-3	Chloromethane	ND	600	37	ug/kg	
95-49-8	o-Chlorotoluene	ND	600	21	ug/kg	
106-43-4	p-Chlorotoluene	ND	600	41	ug/kg	
108-20-3	Di-Isopropyl ether	ND	240	16	ug/kg	
96-12-8	1,2-Dibromo-3-chloropropane	ND	600	200	ug/kg	
124-48-1	Dibromochloromethane	ND	240	34	ug/kg	
106-93-4	1,2-Dibromoethane	ND	240	32	ug/kg	
95-50-1	1,2-Dichlorobenzene	ND	240	21	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	240	43	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	240	53	ug/kg	
75-71-8	Dichlorodifluoromethane	ND	240	15	ug/kg	
75-34-3	1,1-Dichloroethane	ND	240	32	ug/kg	
107-06-2	1,2-Dichloroethane	ND	240	16	ug/kg	
75-35-4	1,1-Dichloroethene	ND	240	39	ug/kg	
156-59-2	cis-1,2-Dichloroethene	132	240	32	ug/kg	J
156-60-5	trans-1,2-Dichloroethene	ND	240	41	ug/kg	

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID:	045162-95RFRANK-WESTFILL	
Lab Sample ID:	M69764-4	Date Sampled: 12/14/07
Matrix:	SO - Soil	Date Received: 12/17/07
Method:	SW846 8260B	Percent Solids: 80.3
Project:	GEI Tufts Street Somerville MA	

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
78-87-5	1,2-Dichloropropane	ND	240	27	ug/kg	
142-28-9	1,3-Dichloropropane	ND	600	120	ug/kg	
594-20-7	2,2-Dichloropropane	ND	600	26	ug/kg	
563-58-6	1,1-Dichloropropene	ND	600	22	ug/kg	
10061-01-5	cis-1,3-Dichloropropene	ND	240	22	ug/kg	
10061-02-6	trans-1,3-Dichloropropene	ND	240	19	ug/kg	
123-91-1	1,4-Dioxane	ND	3000	1900	ug/kg	
60-29-7	Ethyl Ether	ND	600	50	ug/kg	
100-41-4	Ethylbenzene	ND	240	19	ug/kg	
87-68-3	Hexachlorobutadiene	ND	600	60	ug/kg	
591-78-6	2-Hexanone	ND	600	190	ug/kg	
98-82-8	Isopropylbenzene	ND	600	18	ug/kg	
99-87-6	p-Isopropyltoluene	ND	600	25	ug/kg	
1634-04-4	Methyl Tert Butyl Ether	ND	240	80	ug/kg	
108-10-1	4-Methyl-2-pentanone (MIBK)	ND	600	80	ug/kg	
74-95-3	Methylene bromide	ND	600	64	ug/kg	
75-09-2	Methylene chloride	ND	240	59	ug/kg	
91-20-3	Naphthalene	ND	600	45	ug/kg	
103-65-1	n-Propylbenzene	ND	600	12	ug/kg	
100-42-5	Styrene	ND	600	72	ug/kg	
994-05-8	tert-Amyl Methyl Ether	ND	600	50	ug/kg	
637-92-3	tert-Butyl Ethyl Ether	ND	240	21	ug/kg	
630-20-6	1,1,1,2-Tetrachloroethane	ND	600	30	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	240	48	ug/kg	
127-18-4	Tetrachloroethene	5640	240	28	ug/kg	
109-99-9	Tetrahydrofuran	ND	1200	48	ug/kg	
108-88-3	Toluene	ND	600	20	ug/kg	
87-61-6	1,2,3-Trichlorobenzene	ND	600	84	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	600	48	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	240	20	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	240	34	ug/kg	
79-01-6	Trichloroethene	660	240	32	ug/kg	
75-69-4	Trichlorofluoromethane	ND	240	18	ug/kg	
96-18-4	1,2,3-Trichloropropane	ND	600	75	ug/kg	
95-63-6	1,2,4-Trimethylbenzene	ND	600	24	ug/kg	
108-67-8	1,3,5-Trimethylbenzene	ND	600	24	ug/kg	
75-01-4	Vinyl chloride	ND	240	26	ug/kg	
	m,p-Xylene	ND	240	34	ug/kg	
95-47-6	o-Xylene	ND	240	22	ug/kg	
1330-20-7	Xylene (total)	ND	240	22	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID:	045162-95RFRANK-WESTFILL	Date Sampled:	12/14/07
Lab Sample ID:	M69764-4	Date Received:	12/17/07
Matrix:	SO - Soil	Percent Solids:	80.3
Method:	SW846 8260B		
Project:	GEI Tufts Street Somerville MA		

VOA MCP List

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	107%		60-150%
2037-26-5	Toluene-D8	104%		73-125%
460-00-4	4-Bromofluorobenzene	108%		70-141%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTFILL

Lab Sample ID: M69764-4

Date Sampled: 12/14/07

Matrix: SO - Soil

Date Received: 12/17/07

Method: SW846 8270C SW846 3545

Percent Solids: 80.3

Project: GEI Tufts Street Somerville MA

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	I50738.D	1	12/21/07	AT	12/18/07	OP14922	MSI1587
Run #2							

	Initial Weight	Final Volume
Run #1	20.1 g	1.0 ml
Run #2		

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
65-85-0	Benzoic acid	ND	620	20	ug/kg	
95-57-8	2-Chlorophenol	ND	310	18	ug/kg	
59-50-7	4-Chloro-3-methyl phenol	ND	620	16	ug/kg	
120-83-2	2,4-Dichlorophenol	ND	620	37	ug/kg	
105-67-9	2,4-Dimethylphenol	ND	620	95	ug/kg	
51-28-5	2,4-Dinitrophenol	ND	1200	53	ug/kg	
95-48-7	2-Methylphenol	63.3	620	19	ug/kg	J
	3&4-Methylphenol	148	620	23	ug/kg	J
88-75-5	2-Nitrophenol	ND	620	7.9	ug/kg	
100-02-7	4-Nitrophenol	ND	1200	120	ug/kg	
87-86-5	Pentachlorophenol	ND	620	290	ug/kg	
108-95-2	Phenol	ND	310	310	ug/kg	
95-95-4	2,4,5-Trichlorophenol	ND	620	20	ug/kg	
88-06-2	2,4,6-Trichlorophenol	ND	620	9.4	ug/kg	
83-32-9	Acenaphthene	56.3	310	12	ug/kg	J
208-96-8	Acenaphthylene	264	310	7.8	ug/kg	J
98-86-2	Acetophenone	ND	620	8.2	ug/kg	
62-53-3	Aniline	ND	620	40	ug/kg	
120-12-7	Anthracene	136	310	6.9	ug/kg	J
56-55-3	Benzo(a)anthracene	327	310	8.6	ug/kg	
50-32-8	Benzo(a)pyrene	305	310	36	ug/kg	J
205-99-2	Benzo(b)fluoranthene	671	310	11	ug/kg	
191-24-2	Benzo(g,h,i)perylene	363	310	12	ug/kg	
207-08-9	Benzo(k)fluoranthene	301	310	9.5	ug/kg	J
101-55-3	4-Bromophenyl phenyl ether	ND	310	13	ug/kg	
85-68-7	Butyl benzyl phthalate	ND	310	10	ug/kg	
91-58-7	2-Chloronaphthalene	ND	310	8.4	ug/kg	
106-47-8	4-Chloroaniline	ND	620	26	ug/kg	
218-01-9	Chrysene	323	310	9.7	ug/kg	
111-91-1	bis(2-Chloroethoxy)methane	ND	310	14	ug/kg	
111-44-4	bis(2-Chloroethyl)ether	ND	310	13	ug/kg	
108-60-1	bis(2-Chloroisopropyl)ether	ND	310	6.9	ug/kg	

ND = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTFILL	Date Sampled: 12/14/07
Lab Sample ID: M69764-4	Date Received: 12/17/07
Matrix: SO - Soil	Percent Solids: 80.3
Method: SW846 8270C SW846 3545	
Project: GEI Tufts Street Somerville MA	

ABN MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
95-50-1	1,2-Dichlorobenzene	ND	310	14	ug/kg	
122-66-7	1,2-Diphenylhydrazine	ND	310	4.8	ug/kg	
541-73-1	1,3-Dichlorobenzene	ND	310	12	ug/kg	
106-46-7	1,4-Dichlorobenzene	ND	310	14	ug/kg	
121-14-2	2,4-Dinitrotoluene	ND	620	8.4	ug/kg	
606-20-2	2,6-Dinitrotoluene	ND	620	16	ug/kg	
91-94-1	3,3'-Dichlorobenzidine	ND	310	43	ug/kg	
53-70-3	Dibenzo(a,h)anthracene	292	310	14	ug/kg	J
132-64-9	Dibenzofuran	151	310	11	ug/kg	J
84-74-2	Di-n-butyl phthalate	ND	310	12	ug/kg	
117-84-0	Di-n-octyl phthalate	ND	310	32	ug/kg	
84-66-2	Diethyl phthalate	ND	310	9.7	ug/kg	
131-11-3	Dimethyl phthalate	ND	310	7.1	ug/kg	
117-81-7	bis(2-Ethylhexyl)phthalate	208	310	23	ug/kg	J
206-44-0	Fluoranthene	808	310	13	ug/kg	
86-73-7	Fluorene	145	310	9.9	ug/kg	J
118-74-1	Hexachlorobenzene	ND	310	11	ug/kg	
87-68-3	Hexachlorobutadiene	ND	310	18	ug/kg	
77-47-4	Hexachlorocyclopentadiene	ND	620	14	ug/kg	
67-72-1	Hexachloroethane	ND	310	11	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	350	310	20	ug/kg	
78-59-1	Isophorone	ND	310	12	ug/kg	
91-57-6	2-Methylnaphthalene	553	310	11	ug/kg	
91-20-3	Naphthalene	3600	310	13	ug/kg	
98-95-3	Nitrobenzene	ND	310	17	ug/kg	
621-64-7	N-Nitroso-di-n-propylamine	ND	310	16	ug/kg	
86-30-6	N-Nitrosodiphenylamine	ND	310	6.6	ug/kg	
85-01-8	Phenanthrene	620	310	4.8	ug/kg	
129-00-0	Pyrene	602	310	4.4	ug/kg	
120-82-1	1,2,4-Trichlorobenzene	ND	310	10	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
367-12-4	2-Fluorophenol	67%		20-120%
4165-62-2	Phenol-d5	73%		23-120%
118-79-6	2,4,6-Tribromophenol	86%		10-120%
4165-60-0	Nitrobenzene-d5	66%		20-118%
321-60-8	2-Fluorobiphenyl	78%		30-115%
1718-51-0	Terphenyl-d14	72%		32-126%

ND = Not detected MDL - Method Detection Limit
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J = Indicates an estimated value
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 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.4

Client Sample ID: 045162-95RFRANK-WESTFILL
 Lab Sample ID: M69764-4
 Matrix: SO - Soil
 Method: MADEP EPH REV 1.1 SW846 3545
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07
 Date Received: 12/17/07
 Percent Solids: 80.3

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	PO52466.D	1	12/20/07	SL	12/18/07	OP14923	GPO3094
Run #2							

Run #	Initial Weight	Final Volume
Run #1	10.3 g	2.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
83-32-9	Acenaphthene	ND	600	480	ug/kg	
208-96-8	Acenaphthylene	ND	600	480	ug/kg	
120-12-7	Anthracene	ND	600	480	ug/kg	
56-55-3	Benzo(a)anthracene	ND	600	480	ug/kg	
50-32-8	Benzo(a)pyrene	ND	600	480	ug/kg	
205-99-2	Benzo(b)fluoranthene	ND	600	480	ug/kg	
191-24-2	Benzo(g,h,i)perylene	ND	600	480	ug/kg	
207-08-9	Benzo(k)fluoranthene	ND	600	480	ug/kg	
218-01-9	Chrysene	ND	600	480	ug/kg	
53-70-3	Dibenz(a,h)anthracene	ND	600	480	ug/kg	
206-44-0	Fluoranthene	580	600	480	ug/kg	J
86-73-7	Fluorene	ND	600	480	ug/kg	
193-39-5	Indeno(1,2,3-cd)pyrene	ND	600	480	ug/kg	
91-57-6	2-Methylnaphthalene	ND	600	480	ug/kg	
91-20-3	Naphthalene	ND	600	480	ug/kg	
85-01-8	Phenanthrene	ND	600	480	ug/kg	
129-00-0	Pyrene	566	600	480	ug/kg	J
	C11-C22 Aromatics (Unadj.)	24200	24000	21000	ug/kg	
	C9-C18 Aliphatics	ND	12000	9700	ug/kg	
	C19-C36 Aliphatics	20200	12000	9700	ug/kg	
	C11-C22 Aromatics	ND	24000	21000	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
84-15-1	o-Terphenyl	84%		40-140%
321-60-8	2-Fluorobiphenyl	78%		40-140%
580-13-2	2-Bromonaphthalene	82%		40-140%
3386-33-2	1-Chlorooctadecane	48%		40-140%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID:	045162-95RFRANK-WESTFILL	
Lab Sample ID:	M69764-4	Date Sampled: 12/14/07
Matrix:	SO - Soil	Date Received: 12/17/07
Method:	SW846 8082 SW846 3510C	Percent Solids: 80.3
Project:	GEI Tufts Street Somerville MA	

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	EF59205.D	1	12/24/07	SL	12/20/07	OP14931	GEF2829
Run #2							

	Initial Weight	Final Volume
Run #1	15.8 g	10.0 ml
Run #2		

PCB List

CAS No.	Compound	Result	RL	MDL	Units	Q
12674-11-2	Aroclor 1016	ND	120	16	ug/kg	
11104-28-2	Aroclor 1221	ND	120	6.0	ug/kg	
11141-16-5	Aroclor 1232	ND	120	13	ug/kg	
53469-21-9	Aroclor 1242	ND	120	9.7	ug/kg	
12672-29-6	Aroclor 1248	ND	120	8.0	ug/kg	
11097-69-1	Aroclor 1254	ND	120	7.2	ug/kg	
11096-82-5	Aroclor 1260	ND	120	12	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
877-09-8	Tetrachloro-m-xylene	84%		30-140%
877-09-8	Tetrachloro-m-xylene	91%		30-140%
2051-24-3	Decachlorobiphenyl	114%		30-150%
2051-24-3	Decachlorobiphenyl	131%		30-150%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRANK-WESTFILL

Lab Sample ID: M69764-4

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07

Date Received: 12/17/07

Percent Solids: 80.3

Metals Analysis

Analyte	Result	RL	Units	DF	Prep	Analyzed By	Method	Prep Method
Arsenic	19.2	2.3	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Cadmium	<0.47	0.47	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Chromium	23.2	1.2	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Lead	874	2.3	mg/kg	1	12/19/07	12/20/07 PY	SW846 6010B ²	SW846 3050B ⁴
Mercury	0.71	0.037	mg/kg	1	12/18/07	12/19/07 MA	SW846 7471A ¹	SW846 7471A ³

(1) Instrument QC Batch: MA8807

(2) Instrument QC Batch: MA8818

(3) Prep QC Batch: MP11293

(4) Prep QC Batch: MP11300

RL = Reporting Limit

Report of Analysis

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3.4

Client Sample ID: 045162-95RFRANK-WESTFILL

Lab Sample ID: M69764-4

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 12/14/07

Date Received: 12/17/07

Percent Solids: 80.3

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Corrosivity as pH	9.8			1	12/18/07	MA	SW846 CHAP7
Cyanide Reactivity	< 1.9	1.9	mg/kg	1	12/19/07	BF	SW846 CHAP7
Ignitability (Flashpoint)	> 230		Deg. F	1	12/22/07	MA	SW846 1020
Solids, Percent	80.3		%	1	12/18/07	CF	SM21 2540 B MOD.
Specific Conductivity	361	0.50	umhos/cm	1	12/18/07	MA	EPA 120.1M
Sulfide Reactivity	< 62	62	mg/kg	1	12/19/07	BF	SW846 CHAP7
Total Organic Carbon	159000	11000	mg/kg	1	12/20/07 18:56	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RBACK SOIL-1
 Lab Sample ID: M70137-1
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 01/08/08
 Date Received: 01/10/08
 Percent Solids: 79.5

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	K22642.D	1	01/22/08	PB	n/a	n/a	MSK806
Run #2							

	Initial Weight	Final Volume	Methanol Aliquot
Run #1	9.15 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
56-23-5	Carbon tetrachloride	ND	160	13	ug/kg	
75-00-3	Chloroethane	ND	410	21	ug/kg	
75-34-3	1,1-Dichloroethane	ND	160	22	ug/kg	
107-06-2	1,2-Dichloroethane	ND	160	11	ug/kg	
75-35-4	1,1-Dichloroethene	ND	160	27	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	160	21	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	160	28	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	160	32	ug/kg	
127-18-4	Tetrachloroethene	ND	160	19	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	160	13	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	160	23	ug/kg	
79-01-6	Trichloroethene	ND	160	21	ug/kg	
75-01-4	Vinyl chloride	ND	160	17	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	101%		60-150%
2037-26-5	Toluene-D8	97%		73-125%
460-00-4	4-Bromofluorobenzene	99%		70-141%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.2

3

Client Sample ID: 045162-95RBACK SOIL-0-3
 Lab Sample ID: M70137-2
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 01/08/08
 Date Received: 01/10/08
 Percent Solids: 79.5

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	K22643.D	1	01/22/08	PB	n/a	n/a	MSK806
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	9.64 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
56-23-5	Carbon tetrachloride	ND	160	12	ug/kg	
75-00-3	Chloroethane	ND	390	20	ug/kg	
75-34-3	1,1-Dichloroethane	ND	160	21	ug/kg	
107-06-2	1,2-Dichloroethane	ND	160	10	ug/kg	
75-35-4	1,1-Dichloroethene	ND	160	25	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	160	20	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	160	27	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	160	31	ug/kg	
127-18-4	Tetrachloroethene	ND	160	18	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	160	13	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	160	22	ug/kg	
79-01-6	Trichloroethene	ND	160	20	ug/kg	
75-01-4	Vinyl chloride	ND	160	16	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	107%		60-150%
2037-26-5	Toluene-D8	99%		73-125%
460-00-4	4-Bromofluorobenzene	102%		70-141%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RBACK SOIL-0-3

Lab Sample ID: M70137-2

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 01/08/08

Date Received: 01/10/08

Percent Solids: 79.5

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	79.5		%	1	01/11/08	NJ	SM21 2540 B MOD.
Total Organic Carbon	53000	2800	mg/kg	1	01/23/08 11:16	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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33

Client Sample ID: 045162-95RBACK SOIL-5-7
 Lab Sample ID: M70137-3
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 01/08/08
 Date Received: 01/10/08
 Percent Solids: 80.7

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	K22644.D	1	01/22/08	PB	n/a	n/a	MSK806
Run #2							

	Initial Weight	Final Volume	Methanol Aliquot
Run #1	7.83 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
56-23-5	Carbon tetrachloride	ND	180	14	ug/kg	
75-00-3	Chloroethane	ND	460	24	ug/kg	
75-34-3	1,1-Dichloroethane	ND	180	24	ug/kg	
107-06-2	1,2-Dichloroethane	ND	180	12	ug/kg	
75-35-4	1,1-Dichloroethene	ND	180	30	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	180	24	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	180	31	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	180	36	ug/kg	
127-18-4	Tetrachloroethene	ND	180	21	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	180	15	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	180	26	ug/kg	
79-01-6	Trichloroethene	ND	180	24	ug/kg	
75-01-4	Vinyl chloride	ND	180	19	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	105%		60-150%
2037-26-5	Toluene-D8	98%		73-125%
460-00-4	4-Bromofluorobenzene	102%		70-141%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.3

3

Client Sample ID: 045162-95RBACK SOIL-5-7

Lab Sample ID: M70137-3

Matrix: SO - Soil

Project: GEI Tufts Street Somerville MA

Date Sampled: 01/08/08

Date Received: 01/10/08

Percent Solids: 80.7

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	80.7		%	1	01/11/08	NJ	SM21 2540 B MOD.
Total Organic Carbon	<1200	1200	mg/kg	1	01/23/08 11:02	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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3.4

3

Client Sample ID: 045162-95RFRONT SOIL-1
 Lab Sample ID: M70137-4
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 01/09/08
 Date Received: 01/10/08
 Percent Solids: 82.0

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	K22645.D	1	01/22/08	PB	n/a	n/a	MSK806
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	10.9 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
56-23-5	Carbon tetrachloride	ND	130	11	ug/kg	
75-00-3	Chloroethane	ND	330	17	ug/kg	
75-34-3	1,1-Dichloroethane	ND	130	18	ug/kg	
107-06-2	1,2-Dichloroethane	ND	130	8.8	ug/kg	
75-35-4	1,1-Dichloroethene	ND	130	22	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	130	17	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	130	23	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	130	26	ug/kg	
127-18-4	Tetrachloroethene	ND	130	15	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	130	11	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	130	19	ug/kg	
79-01-6	Trichloroethene	ND	130	17	ug/kg	
75-01-4	Vinyl chloride	ND	130	14	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	104%		60-150%
2037-26-5	Toluene-D8	97%		73-125%
460-00-4	4-Bromofluorobenzene	100%		70-141%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.5

3

Client Sample ID: 045162-95RFRONT SOIL-0-3

Lab Sample ID: M70137-5

Date Sampled: 01/09/08

Matrix: SO - Soil

Date Received: 01/10/08

Method: SW846 8260B

Percent Solids: 82.0

Project: GEI Tufts Street Somerville MA

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	K22646.D	1	01/22/08	PB	n/a	n/a	MSK806
Run #2							

	Initial Weight	Final Volume	Methanol Aliquot
Run #1	12.4 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
56-23-5	Carbon tetrachloride	ND	120	9.5	ug/kg	
75-00-3	Chloroethane	ND	300	16	ug/kg	
75-34-3	1,1-Dichloroethane	ND	120	16	ug/kg	
107-06-2	1,2-Dichloroethane	ND	120	7.9	ug/kg	
75-35-4	1,1-Dichloroethene	ND	120	20	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	120	16	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	120	20	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	120	24	ug/kg	
127-18-4	Tetrachloroethene	ND	120	14	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	120	9.9	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	120	17	ug/kg	
79-01-6	Trichloroethene	ND	120	16	ug/kg	
75-01-4	Vinyl chloride	ND	120	13	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	104%		60-150%
2037-26-5	Toluene-D8	99%		73-125%
460-00-4	4-Bromofluorobenzene	103%		70-141%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.5

Client Sample ID: 045162-95RFRONT SOIL-0-3
Lab Sample ID: M70137-5
Matrix: SO - Soil
Project: GEI Tufts Street Somerville MA

Date Sampled: 01/09/08
Date Received: 01/10/08
Percent Solids: 82.0

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	82		%	1	01/11/08	NJ	SM21 2540 B MOD.
Total Organic Carbon	29800	2500	mg/kg	1	01/23/08 12:11	CF	SW 846 9060M

RL = Reporting Limit

Report of Analysis

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Client Sample ID: 045162-95RFRONT SOIL-7-8
 Lab Sample ID: M70137-6
 Matrix: SO - Soil
 Method: SW846 8260B
 Project: GEI Tufts Street Somerville MA

Date Sampled: 01/09/08
 Date Received: 01/10/08
 Percent Solids: 77.7

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	K22647.D	1	01/22/08	PB	n/a	n/a	MSK806
Run #2							

Run #	Initial Weight	Final Volume	Methanol Aliquot
Run #1	5.77 g	10.0 ml	100 ul
Run #2			

VOA MCP List

CAS No.	Compound	Result	RL	MDL	Units	Q
56-23-5	Carbon tetrachloride	ND	250	20	ug/kg	
75-00-3	Chloroethane	ND	630	33	ug/kg	
75-34-3	1,1-Dichloroethane	ND	250	33	ug/kg	
107-06-2	1,2-Dichloroethane	ND	250	17	ug/kg	
75-35-4	1,1-Dichloroethene	ND	250	41	ug/kg	
156-59-2	cis-1,2-Dichloroethene	ND	250	33	ug/kg	
156-60-5	trans-1,2-Dichloroethene	ND	250	43	ug/kg	
79-34-5	1,1,2,2-Tetrachloroethane	ND	250	50	ug/kg	
127-18-4	Tetrachloroethene	ND	250	29	ug/kg	
71-55-6	1,1,1-Trichloroethane	ND	250	21	ug/kg	
79-00-5	1,1,2-Trichloroethane	ND	250	36	ug/kg	
79-01-6	Trichloroethene	ND	250	33	ug/kg	
75-01-4	Vinyl chloride	ND	250	27	ug/kg	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	103%		60-150%
2037-26-5	Toluene-D8	98%		73-125%
460-00-4	4-Bromofluorobenzene	100%		70-141%

ND = Not detected MDL - Method Detection Limit
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

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3.6

Client Sample ID: 045162-95RFRONT SOIL-7-8
Lab Sample ID: M70137-6
Matrix: SO - Soil
Project: GEI Tufts Street Somerville MA

Date Sampled: 01/09/08
Date Received: 01/10/08
Percent Solids: 77.7

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Solids, Percent	77.7		%	1	01/11/08	NJ	SM21 2540 B MOD.
Total Organic Carbon	6020	1400	mg/kg	1	01/23/08 12:41	CF	SW 846 9060M

RL = Reporting Limit

Attachment B

Site Specific Risk Assessment



Memo

To **Ileen Gladstone / GEI** File no
From **Allison Nightingale** cc
Brian Magee
Tel **781-721-4000**
Fax **781-721-4073**
Date **February 11, 2008**

Subject 95R Franklin Street Risk Characterization

AMEC Earth & Environmental, Inc. (AMEC) conducted a risk characterization to evaluate potential risks associated with contacting volatile organic compounds (VOCs) detected in soil samples collected from beneath the basement slab and outside the footprint of the existing structure at the 95R Franklin Street property. We conducted the risk characterization consistent with the Method 3 approach described in the Massachusetts Department of Environmental Protection (MassDEP) *Guidance for Disposal Site Risk Characterization - In Support of the MCP* (MassDEP, 1995) and current risk assessment practice in Massachusetts. The risk characterization evaluated health risks potentially posed to residents who may contact compounds in soil via incidental ingestion of soil, skin contact with soil, and inhalation of compounds that have volatilized from soil and migrated to air outside the existing structure.

We estimated exposure point concentrations (EPCs) assuming that soil at all locations from which samples were collected could be contacted by residents. Several of the samples were collected from beneath the basement slab, and contacting soil from these locations would only be possible if the existing structure were removed. Our review of the results of the soil sample analyses reveals that concentrations of VOCs in soil beneath the structure are higher than in soil outside the footprint of the structure. Indeed, only one compound was detected (and at low concentrations) in soil outside the existing structure. For this reason, assuming that residents may contact soil from beneath the basement slab frequently and over a long period of time will overestimate potential exposures and health risks associated with current conditions at the property (that is, with the existing structure in place). However, for the purposes of estimating potential exposures and health risks associated with a hypothetical future condition, in which the structure may no longer be present, we have conservatively assumed that residents may contact soil from all sampled locations. Table 1 shows the EPCs for VOCs in soil.

Table 1 Exposure Point Concentrations of VOCs in Soil	
Compound	Exposure Point Concentration (mg/kg)
Tetrachloroethene	10.5
Trichloroethene	0.9
Benzene	0.03
Dichlorobenzene, 1,3- (m-DCB)	0.1
Dichlorobenzene, 1,4- (p-DCB)	0.1
Dichloroethane, 1,1-	0.1
Dichloroethylene, 1,1-	0.1
Dichloroethylene, cis-1,2-	0.1
Ethylbenzene	0.09
Methylene Chloride	0.1
Toluene	0.2
Trichloroethane, 1,1,1-	0.09
Trimethylbenzene, 1,2,4-	0.2
m-Xylene	0.06
p-Xylene	0.06
o-Xylene	0.09
Naphthalene	0.2

The residential exposure and toxicity parameter values used in this risk characterization are values recommended by MassDEP. The exposure parameter values are shown in Table 2, and the toxicity values are shown in Table 3.

Table 2 Exposure Parameter Values			
Parameter (Units)	Young Child Resident	Older Child Resident	Adult Resident
Soil Ingestion Rate (mg/day)	100	50	50
Skin Exposed (cm ² /day)	2,431	4,427	5,653
Soil Adherence Rate (mg/cm ²)	0.35	0.14	0.13
Inhalation Exposure Time (hours/day)	8	8	8
Exposure Frequency (days/year)	150	150	150
Exposure Period (years)	7	7	16
Averaging Time – Cancer (days)	25550	25550	25550
Averaging Time - Non-Cancer (days)	2555	NA	NA
Body Weight (kg)	17	39.9	58.7

NA – Not applicable; non-carcinogenic risk characterization evaluates young child exposure only.

Table 3 Carcinogenic and Non-Carcinogenic Toxicity Factors

Compound	Oral Cancer Slope Factor (mg/kg-d)⁻¹	Inhalation Unit Risk Factor (ug/m³)⁻¹	Oral Reference Dose (mg/kg-d)	Inhalation Reference Concentration (mg/m³)
Tetrachloroethene	0.051	0.00001	0.01	4.6
Trichloroethene	0.011	0.0000017	0.002	0.18
Benzene	0.055	0.0000078	0.004	0.03
Dichlorobenzene, 1,3- (m-DCB)	NA	NA	0.09	0.2
Dichlorobenzene, 1,4- (p-DCB)	0.024	0.0000069	0.09	0.8
Dichloroethane, 1,1-	NA	NA	0.1	0.5
Dichloroethylene, 1,1-	NA	NA	0.05	0.2
Dichloroethylene, cis-1,2-	NA	NA	0.01	0.035
Ethylbenzene	NA	NA	0.1	1
Methylene Chloride	0.0075	0.00000047	0.06	3
Toluene	NA	NA	0.2	0.4
Trichloroethane, 1,1,1-	NA	NA	0.09	5.2
Trimethylbenzene, 1,2,4-	NA	NA	0.05	0.00595
m-Xylene	NA	NA	0.2	0.1
p-Xylene	NA	NA	0.2	0.1
o-Xylene	NA	NA	0.2	0.1
Naphthalene	NA	NA	0.2	0.1

NA – Not applicable; this compound is not considered to be potentially carcinogenic.

We compared the estimated potential risks to MassDEP's acceptable risk limits. Estimated potential carcinogenic and non-carcinogenic risks are shown in Table 4, along with MassDEP's acceptable risk limits.

Table 4 Estimated Potential Carcinogenic and Non-Carcinogenic Risks

Compound	Excess Lifetime Cancer Risk	Hazard Index
Tetrachloroethene	5×10^{-7}	0.005
Trichloroethene	9×10^{-9}	0.002
Benzene	1×10^{-9}	0.00003
Dichlorobenzene, 1,3- (m-DCB)	NA	0.000006
Dichlorobenzene, 1,4- (p-DCB)	2×10^{-9}	0.000006
Dichloroethane, 1,1-	NA	0.000007
Dichloroethylene, 1,1-	NA	0.00001
Dichloroethylene, cis-1,2-	NA	0.00007
Ethylbenzene	NA	0.000006
Methylene Chloride	6×10^{-10}	0.000007
Toluene	NA	0.000005

Table 4 Estimated Potential Carcinogenic and Non-Carcinogenic Risks

Compound	Excess Lifetime Cancer Risk	Hazard Index
Trichloroethane, 1,1,1-	NA	0.000004
Trimethylbenzene, 1,2,4-	NA	0.00006
m-Xylene	NA	0.000002
p-Xylene	NA	0.000002
o-Xylene	NA	0.000002
Naphthalene	NA	0.000006
Total	5×10^{-7}	0.007
MassDEP Acceptable Risk Limit	1×10^{-5}	1

NA – Not applicable; this compound is not considered to be potentially carcinogenic.

As shown in Table 4, the total potential carcinogenic risk associated with residents contacting VOCs in soil from beneath the existing structure and from outside the footprint of the structure is 5×10^{-7} , which is 20-fold lower than MassDEP's acceptable carcinogenic risk limit of 1×10^{-5} . Thus, conditions in soil at this property do not pose a significant carcinogenic risk. The total non-carcinogenic hazard index is 0.007, which is approximately 150-fold lower than MassDEP's acceptable noncarcinogenic risk limit of 1. Thus, conditions at this property do not pose a significant non-carcinogenic risk.

Attachment C

Reporting Exemption Memorandum

Memo

To: File
From: Ileen Gladstone, P.E., LSP
Date: 2/15/2008
Re: 95R Franklin Street, Somerville, Massachusetts
 MCP Reporting Exemptions due to Lead Paint and Coal, Coal Ash and Wood Ash
 GEI Project Number – 045162

GEI microscopically examined soil sample 045162-95RFRANK-NorthFill-6-8, which was collected from beneath the basement slab at 95R Franklin Street. Based on the examination, the soil contains various materials associated with urban soils, including brick, coal ash, fiber, glass, and paint chips. The microscopic inspection of the soil sample indicated:

- Medium Sand (90%): quartz, feldspar, mica
- Coal and coal ash (2-5%): black, fine-medium grained
- Other debris (2-5%): glass and brick fragments, white-gray paint chips, fibers

Lead, arsenic and several polyaromatic hydrocarbons (PAHs) were detected above the applicable Massachusetts Contingency Plan (MCP) reportable concentration (RCS1) in several soil samples collected at 95R Franklin Street. It is GEI's opinion that the lead detected in the soil samples are related to paint chips observed in the soil and are exempt from notification in accordance with the MCP, 310 CMR 40.0317(8). In addition, it is GEI's opinion that the arsenic and PAHs detected in the soil samples are related to ash, coal ash, or wood ash, and are also exempt from notification in accordance with the MCP, 310 CMR 40.0317(9).

This opinion is based on:

The material excavated from beneath the slab at 95R Franklin Street clearly contained fill material, which is consistent with areas of known filling in the neighborhood.

Based on GEI's microscopic observation of soil sample, there is a significant presence of paint chips, ash, coal, or coal ash.

- There is no indication of a known discrete release of oil and/or hazardous materials other than the chlorinated VOCs associated with the 50 Tufts Street disposal site.
- The concentrations of arsenic and PAHs detected in soil samples from the Site are within the ranges of concentrations of arsenic and PAHs reported in the "Methods for Evaluating the Application of the Coal and Wood Ash Exemption Under the Massachusetts Contingency Plan," October 19, 1999, prepared by the LSP Association, as shown on Table 1.
- The laboratory analyses results did not indicate other chemical constituents that would have indicated other disposal practices.

Table 1**Comparison of SVOCs and Arsenic detected at 95R Franklin Street with Reportable Concentrations and the Coal Ash/Wood Ash Group Concentrations****50 Tufts Street****Somerville, Massachusetts**

Compounds	95R Franklin Street, Somerville Detected Range (mg/kg) ⁽¹⁾	RCS1 (mg/kg)	Coal Ash/Wood Ash Group Detected Range (mg/kg) ^(2, 3)
Benzo(a)pyrene	<0.290 – 6.25	2	0.230 - 18
Dibenz(a,h)anthracene	0.460 J – 0.959	0.7	0.570
Naphthalene	0.0638 J – 5.3	4	0.0083 – 2.3
Arsenic	10.9 – 36.4	20	0.02 – 168

Notes:

1. Chemical testing results as reported in our letter to Susan Southwick entitled, "Soil and Indoor Air Sampling Results, 95R Franklin Street, Somerville, Massachusetts" dated February 15, 2008.
2. Concentrations cited from Table 4: Polycyclic Aromatic Hydrocarbon Concentrations in Coal Ash of "Methods for evaluating Application of the Coal and Wood Ash Exemption under the Massachusetts Contingency Plan," October 19, 1999, prepared by the LSP Association.
3. Concentrations cited from Table 3a: Concentration Ranges for Selected Minor Elements in Fossil Fuel Wastes, Coals and Soils Coal Ash/Wood Ash Work Group of "Methods for Evaluating Application of the Coal and Wood Ash Exemption under the Massachusetts Contingency Plan," October 19, 1999, prepared by the LSP Association.

J = The reported result is below the laboratory reporting limit and is estimated.

mg/kg = Milligrams per kilogram

RC = Reportable Concentration as listed in the Massachusetts Contingency Plan (310 CMR 40.0000) dated February 14, 2008

Attachment D

Indoor Air Laboratory Data Sheets

Report of Analysis

Page 1 of 1

Client Sample ID: 045162-95RFRAN-1A

Lab Sample ID: M69923-1

Date Sampled: 12/23/07

Matrix: AIR - Air Summa ID: M149

Date Received: 12/24/07

Method: TO-15

Percent Solids: n/a

Project: GEI Tufts Street Somerville MA

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	Q5776.D	1	12/26/07	DFT	n/a	n/a	MSQ287
Run #2							

	Initial Volume
Run #1	400 ml
Run #2	

CAS No.	MW	Compound	Result	RL	Units	Q	Result	RL	Units
75-00-3	64.52	Chloroethane	ND	0.20	ppbv		ND	0.53	ug/m3
56-23-5	153.8	Carbon tetrachloride	0.092	0.20	ppbv	J	0.58	1.3	ug/m3
75-34-3	98.96	1,1-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
75-35-4	96.94	1,1-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
107-06-2	98.96	1,2-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
156-60-5	96.94	trans-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
156-59-2	96.94	cis-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
71-55-6	133.4	1,1,1-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
79-34-5	167.9	1,1,2,2-Tetrachloroethane	ND	0.20	ppbv		ND	1.4	ug/m3
79-00-5	133.4	1,1,2-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
127-18-4	165.8	Tetrachloroethylene	0.15	0.20	ppbv	J	1.0	1.4	ug/m3
79-01-6	131.4	Trichloroethylene	ND	0.20	ppbv		ND	1.1	ug/m3
75-01-4	62.5	Vinyl chloride	ND	0.20	ppbv		ND	0.51	ug/m3

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
460-00-4	4-Bromofluorobenzene	84%		57-139%

ND = Not detected

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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Client Sample ID: 045162-95RFRAN-B2
 Lab Sample ID: M69923-2
 Matrix: AIR - Air Summa ID: M218
 Method: TO-15
 Project: GEI Tufts Street Somerville MA

Date Sampled: 12/23/07
 Date Received: 12/24/07
 Percent Solids: n/a

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	Q5777.D	1	12/26/07	DFT	n/a	n/a	MSQ287
Run #2							

	Initial Volume
Run #1	400 ml
Run #2	

CAS No.	MW	Compound	Result	RL	Units	Q	Result	RL	Units
75-00-3	64.52	Chloroethane	ND	0.20	ppbv		ND	0.53	ug/m3
56-23-5	153.8	Carbon tetrachloride	ND	0.20	ppbv		ND	1.3	ug/m3
75-34-3	98.96	1,1-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
75-35-4	96.94	1,1-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
107-06-2	98.96	1,2-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
156-60-5	96.94	trans-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
156-59-2	96.94	cis-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
71-55-6	133.4	1,1,1-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
79-34-5	167.9	1,1,2,2-Tetrachloroethane	ND	0.20	ppbv		ND	1.4	ug/m3
79-00-5	133.4	1,1,2-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
127-18-4	165.8	Tetrachloroethylene	ND	0.20	ppbv		ND	1.4	ug/m3
79-01-6	131.4	Trichloroethylene	ND	0.20	ppbv		ND	1.1	ug/m3
75-01-4	62.5	Vinyl chloride	ND	0.20	ppbv		ND	0.51	ug/m3

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
460-00-4	4-Bromofluorobenzene	84%		57-139%

ND = Not detected
 RL = Reporting Limit
 E = Indicates value exceeds calibration range

J = Indicates an estimated value
 B = Indicates analyte found in associated method blank
 N = Indicates presumptive evidence of a compound

Report of Analysis

Page 1 of 1

Client Sample ID: 045162-95R FRANK-1

Lab Sample ID: M70019-1

Date Sampled: 12/28/07

Matrix: AIR - Air Summa ID: M153

Date Received: 12/28/07

Method: TO-15

Percent Solids: n/a

Project: GEI Tufts Street Somerville MA

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	Q5824.D	1	12/28/07	DFT	n/a	n/a	MSQ289
Run #2							

Initial Volume

Run #1 400 ml

Run #2

CAS No.	MW	Compound	Result	RL	Units	Q	Result	RL	Units
75-00-3	64.52	Chloroethane	ND	0.20	ppbv		ND	0.53	ug/m3
56-23-5	153.8	Carbon tetrachloride	0.098	0.20	ppbv	J	0.62	1.3	ug/m3
75-34-3	98.96	1,1-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
75-35-4	96.94	1,1-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
107-06-2	98.96	1,2-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
156-60-5	96.94	trans-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
156-59-2	96.94	cis-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
71-55-6	133.4	1,1,1-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
79-34-5	167.9	1,1,2,2-Tetrachloroethane	ND	0.20	ppbv		ND	1.4	ug/m3
79-00-5	133.4	1,1,2-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
127-18-4	165.8	Tetrachloroethylene	0.16	0.20	ppbv	J	1.1	1.4	ug/m3
79-01-6	131.4	Trichloroethylene	ND	0.20	ppbv		ND	1.1	ug/m3
75-01-4	62.5	Vinyl chloride	ND	0.20	ppbv		ND	0.51	ug/m3

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
460-00-4	4-Bromofluorobenzene	80%		57-139%

ND = Not detected

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

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3.2

Client Sample ID: 045162-95R FRANK-B

Lab Sample ID: M70019-2

Date Sampled: 12/28/07

Matrix: AIR - Air Summa ID: M116

Date Received: 12/28/07

Method: TO-15

Percent Solids: n/a

Project: GEI Tufts Street Somerville MA

Run #	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	Q5823.D	1	12/28/07	DFT	n/a	n/a	MSQ289
Run #2							

Run #	Initial Volume
Run #1	400 ml
Run #2	

CAS No.	MW	Compound	Result	RL	Units	Q	Result	RL	Units
75-00-3	64.52	Chloroethane	ND	0.20	ppbv		ND	0.53	ug/m3
56-23-5	153.8	Carbon tetrachloride	ND	0.20	ppbv		ND	1.3	ug/m3
75-34-3	98.96	1,1-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
75-35-4	96.94	1,1-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
107-06-2	98.96	1,2-Dichloroethane	ND	0.20	ppbv		ND	0.81	ug/m3
156-60-5	96.94	trans-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
156-59-2	96.94	cis-1,2-Dichloroethylene	ND	0.20	ppbv		ND	0.79	ug/m3
71-55-6	133.4	1,1,1-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
79-34-5	167.9	1,1,2,2-Tetrachloroethane	ND	0.20	ppbv		ND	1.4	ug/m3
79-00-5	133.4	1,1,2-Trichloroethane	ND	0.20	ppbv		ND	1.1	ug/m3
127-18-4	165.8	Tetrachloroethylene	0.16	0.20	ppbv	J	1.1	1.4	ug/m3
79-01-6	131.4	Trichloroethylene	ND	0.20	ppbv		ND	1.1	ug/m3
75-01-4	62.5	Vinyl chloride	ND	0.20	ppbv		ND	0.51	ug/m3

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
460-00-4	4-Bromofluorobenzene	84%		57-139%

ND = Not detected

RL = Reporting Limit

E = Indicates value exceeds calibration range

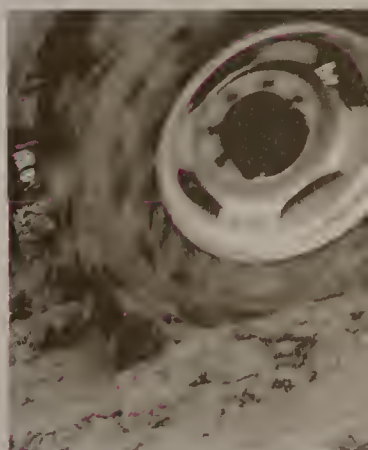
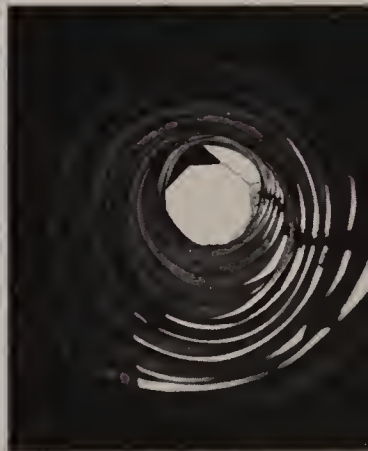
J = Indicates an estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound



Geotechnical
Environmental and
Water Resources
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Appendix L

EPEM Option 2 and 3 Protocols

This protocol describes the proposed vapor mitigation system installation procedure to mitigate potential migration of volatile organic compound (VOC) vapors from below grade into indoor air at buildings within the 50 Tufts Street Site in Somerville, Massachusetts.

1. Contractor mobilization and basement preparation:
 - a. Coordinate building, electrical, plumbing and gas fitting, and fuel oil storage permits with GEI and the City of Somerville Inspectional Services Division and Wire Inspector. Coordinate utility service interruption with electric, natural gas, and water with providers. Obtain parking permits and police details, as necessary.
 - b. Protect first floor living space from item removal and mitigation system installation processes where access to basement is from the interior only (e.g., plastic sheeting and floor protection)
 - c. Contractor will remove stored items necessary to conduct the work and provide temporary storage of these items either on or off site depending on exterior space available at the property.
 - i. Appliances like washers, dryers, and dehumidifiers will be removed and reinstalled.
 - ii. Basement wall coverings, non-structural walls/partitions, and shelving will be removed. Non-structural walls/partitions and shelving will be reinstalled. Wall coverings will be not be reinstalled unless approved by GEI.
 - iii. Insure temporarily stored items against damage.
 - iv. Photo document items removed from residences if requested by GEI.
 - d. Inspect basement once it has been emptied to adjust design and protocol for site specific requirements, (e.g., old furnaces, bathrooms, partitions, wall coverings, non-structural walls, etc.). Prepare a written inspection report documenting any changes to this protocol.
 - e. Dust ventilation and barrier:
 - i. Attach 6-mil minimum thickness polyethylene, or equivalent, sheeting to basement ceiling and doors to minimize dust and fume migration into living space.
 - ii. Set up, run, and remove exhaust fans to create negative pressure in basement during mitigation installation. Vent exhaust to exterior through HEPA filter and if necessary through activated carbon filtration.
 - f. Where there are limited areas for staging of excavated soil, use the following procedure for excavated soil disposal pre-characterization:

50 Tufts Street Site

Option 2 Vapor Barrier and Venting System – Generic Design and Installation Protocol

- i. Core opening in floor slab in at least three perimeter locations to collect a composite soil sample and a VOC grab sample for disposal pre-characterization.
 - ii. Pre-characterization soil samples will be analyzed by a Massachusetts certified laboratory for parameters required by the disposal facility. The laboratory and disposal facility will be retained by the Contractor and approved by GEI. Contractor will coordinate transport and disposal documentation, UniFirst will sign soil disposal documents as the generator. Soil that is classified as mitigation waste will be shipped using a Bill of Lading, GEI will provide an LSP to sign the BOL. [NOTE: should this be Remediation Waste rather than mitigation waste? Do we need this – i.e., will there be any?]
2. Venting system installation – basement:
 - a. Install extraction point(s) near center of structure and/or chimney, or as recommended by GEI. Core a 4-inch diameter hole in floor slab then remove sub grade to create an approximately 10-inch diameter cavity and install pipe into open cavity. Seal pipe to the slab via epoxy resin sealant, or equivalent.
 - b. Saw cut perimeter concrete floor slab for installation of a 1.5-foot wide perimeter venting and water seepage trench.
 - c. Contractor will excavate perimeter venting and seepage trench to a depth of 1.5 feet, slope trench away from foundation, manage excavated soil, and appropriately dispose of soil off site.
 - d. Test excavated soil for VOCs.
 - e. Install filter fabric prior to backfilling trench with stone. Install and compact stone prior to installing vent piping. Install internal perimeter 3-inch perforated PVC passive vent piping. Place and tamp stone around and above perforated piping.
 - f. Incorporate existing sump pump system (if present) into perimeter venting and seepage trench. Incorporation may include installation of a sump vessel with a sealed cover, electrical supply, and discharge piping.
 - g. Use 3-inch diameter schedule 40 PVC pipe to plumb the perimeter vent piping to the exterior at the sill elevation and continue piping to above the roofline.
 - h. Install wind-driven rotary turbine at terminus of vertical piping above roofline.
3. Foundation wall system:
 - a. Remove loose paint, mortar, coatings, and dirt from the brick and fieldstone walls via wire brush and vacuum.

50 Tufts Street Site

Option 2 Vapor Barrier and Venting System – Generic Design and Installation Protocol

- b. Re-point field stone wall with appropriate Portland cement mixture as necessary.
 - c. Install drainage layer composite comprised of drainage grid material and geo-fabric using mechanical fasteners and liquid adhesive to the below grade portion of the foundation walls.
 - d. Apply rubberized asphalt membrane to fabric side of drainage composite with 3-inch shiplap joints and roll joints.
 - e. Drill approximately 3/8-inch holes through membrane, drainage composite, and at least 2-inches into fieldstone. Anchors will be installed into stones and not mortar joints. Install approximately 3/8-inch anchors/threaded rod through composite and membrane with epoxy cement into predrilled holes. Anchors will be installed at an approximately 3-foot grid spacing and top and bottom of fieldstone and brick portions of foundation walls.
 - f. Seal around anchor/rods with rubberized asphalt liquid sealant or equivalent.
 - g. Install stucco 2-inch square lath/mesh with building paper backing over entire wall and tie off to anchor/rods.
 - h. Pour or pump (3,000 psi minimum 28 day strength) concrete cap to cover passive vent trench and tie in base of wall lath/mesh.
 - i. Apply elastomeric sealant at vertical joints (i.e, new/old concrete, stucco/brick, or stucco/new concrete).
 - j. Apply 1-inch thick cementitious stucco to lath/mesh.
4. Concrete floor vapor barrier installation:
- a. Clean existing surface and apply concrete floor leveler approved by epoxy resin manufacturer, if necessary.
 - b. Clean surface including removal of dust, laitance, grease, curing compounds, bond inhibiting materials, waxes, and other potential interferences with the epoxy bonding process.
 - c. Apply low VOC epoxy resin primer to prepare surface for epoxy vapor barrier.
 - d. Apply low VOC epoxy resin to floor in accordance with manufacturer recommendations and allow curing for at least 24 hours.
 - e. Apply protective top coating comprised of cementitious floor leveler approved by epoxy resin manufacturer.

5. Tracer Test

- a. Install tracer gas injection points through the existing concrete slab into pre-existing sub-slab material. The injection points are to be located generally equidistant from the perimeter soil vapor trench and venting locations near the center of the basement foot print. One injection point will be installed per 750 square feet of basement concrete slab. Injection points will be installed via the following:
 - i. Core 6-inch diameter hole through existing slab and remove pre-existing material to a depth of 3 feet below the slab using a vacuum or hand auger. (If the water table is encountered shallow than 3-feet then advance injection point to 1.0 feet above water table)
 - ii. Install ¼ inch threaded stainless steel tubing, Teflon thread sealer, and Swagelok valve with the top of the valve 1-inch below the top of the existing concrete slab. Backfill with Ottawa sand to 2.5 feet below the slab.
 - iii. Backfill hole around stainless steel tubing with a Portland cement plug to 4-inches below top of concrete slab.
 - iv. Install 6-inch outer diameter water-tight flush mounted road box into cored hole and fresh Portland cement. Apply elastomeric sealant to road box flare prior to setting road box.
 - v. Apply elastomeric sealant to the top of Portland cement plug inside road box.
 - vi. Float finish Portland cement over existing slab and road box flare to fill gap between slab and road box above elastomeric sealant.
 - vii. Install road box cover with pentagon center bolt and expandable o-ring.

6. Contractor demobilization:

- a. Containerize and dispose of all construction wastes.
- b. Dispose of construction waste off site at a licensed construction waste material disposal facility.
- c. Reinstall and/or replace shelving, non-structural walls/partitions, appliances, bathrooms, etc.
- d. Return temporarily stored items to basement.

50 Tufts Street Site

Option 3 EPEM Vapor Barrier and Ventilation Piping – Generic Design and Installation Protocol

This protocol describes the proposed EPEM installation procedure to mitigate potential migration of volatile organic compound (VOC) vapors from below grade into indoor air at buildings within the 50 Tufts Street Site in Somerville, Massachusetts.

1. Contractor mobilization and basement preparation:
 - a. Coordinate building, electrical, plumbing and gas fitting, and fuel oil storage permits with GEI and the City of Somerville Inspectional Services Division and Wire Inspector. Coordinate utility service interruption with electric, natural gas, and water with providers. Obtain parking permits and police details, as necessary.
 - b. Protect first floor living space from item removal and mitigation system installation processes where access to basement is from the interior only (e.g., plastic sheeting and floor protection).
 - c. Contractor will remove stored items necessary to conduct the work and provide temporary storage of these items either on or off site depending on exterior space available at the property.
 - i. Appliances like washers, dryers, and dehumidifiers will be removed and reinstalled.
 - ii. Basement wall coverings, non-structural walls/partitions, and shelving will be removed. Non-structural walls/partitions and shelving will be reinstalled. Wall coverings will be not be reinstalled unless approved by GEI.
 - iii. Insure temporarily stored items against damage.
 - iv. Photo document items removed from residences if requested by GEI.
 - d. Inspect basement once it has been emptied to adjust design and protocol for site specific requirements, (e.g., old furnaces, bathrooms, partitions, wall coverings, non-structural walls, etc.).
 - e. Dust ventilation and barrier:
 - i. Attach 6-mil minimum thickness polyethylene, or equivalent, sheeting to basement ceiling and doors to minimize dust and fume migration into living space.
 - ii. Set up, run, and remove exhaust fans to create negative pressure in basement during mitigation installation. Vent exhaust to exterior through HEPA filter and if necessary through activated carbon filtration.
 - f. Where there are limited areas for staging of excavated soil, use the following procedure for excavated soil disposal pre-characterization:
 - i. Core opening in floor slab in at least three perimeter locations to collect a composite soil sample and a VOC grab sample for disposal pre-characterization.

50 Tufts Street Site

Option 3 EPEM Vapor Barrier and Ventilation Piping – Generic Design and Installation Protocol

- ii. Pre-characterization soil samples will be analyzed by a Massachusetts certified laboratory for parameters required by the disposal facility.
- 2. Foundation floor system:
 - a. Saw, cut and remove existing concrete floor slab.
 - b. Excavate adequate volume of soil to maintain appropriate top of slab to floor joist distance, manage excavated soil, and appropriately dispose of soil off site.
 - c. Install ventilation point(s) near center of structure and building corners, or as recommended by GEI. Excavate ventilation point sump up to 1.5 feet below the bottom of the floor slab, wrap walls with filter fabric, and backfill with ½ to ¾-inch gravel.
 - d. Install floor vapor transmission layer that is overlapped 3-inches at seams.
 - e. Install 40-mil HDPE liner over vapor transmission layer that is taped at seams and penetrations.
 - f. Incorporate existing sump pump system (if present) into wall and floor vapor transmission layer. Incorporation may include installation of a sump vessel with a sealed cover, electrical supply, and discharge piping.
 - g. Pour or pump (3,000 psi minimum 28 day strength and fiber additive) concrete floor slab and tie in base of wall lath/mesh.
- 3. Foundation wall system:
 - a. Remove loose paint, mortar, coatings, and dirt from the brick and fieldstone walls via wire brush, vacuum, and water rinse.
 - b. Re-point fieldstone wall with appropriate Portland cement mixture as necessary.
 - c. Drill approximately 3/8-inch holes at least 2-inches into fieldstone. Anchors will be installed into stones and not mortar joints. Install approximately 3/8-inch anchors/threaded rod with epoxy cement into predrilled holes. Anchors will be installed at an approximately 1.5-foot grid spacing and top and bottom of fieldstone and brick portions of foundation walls.
 - d. Install vapor transmission layer comprised of drainage grid material and geo-fabric using mechanical fasteners and liquid adhesive to the below grade portion of the foundation walls.
 - e. Apply rubberized asphalt membrane to interior side of vapor transmission layer with 3-inch shiplap joints and roll joints.
 - f. Seal around anchor/rods with rubberized asphalt liquid sealant or equivalent.
 - g. Install stucco lath/mesh with 6-inch overlap over entire wall and tie off to anchor/rods.
 - h. Apply approximately 1-inch thick cementitious stucco to lath/mesh.

50 Tufts Street Site

Option 3 EPEM Vapor Barrier and Ventilation Piping – Generic Design and Installation Protocol

4. Ventilation piping:

- a. Use 3-inch diameter schedule 40 PVC pipe to plumb ventilation piping to the exterior at the sill elevation and continue piping above the roofline.
- b. Install chimney cap at terminus of vertical piping above roofline.

5. Tracer Test:

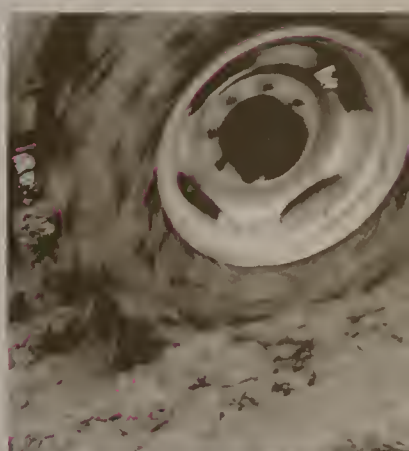
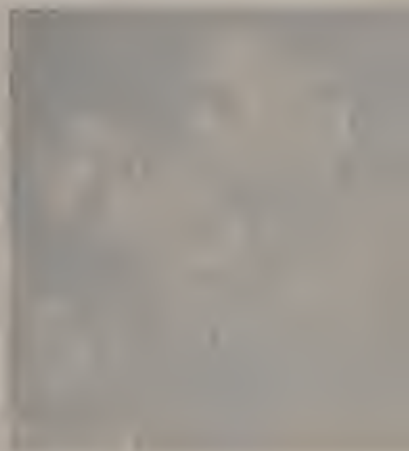
- a. Install tracer gas injection points through the existing concrete slab into pre-existing sub-slab material. The injection points are to be located generally equidistant from venting locations near the center of the basement foot print. One injection point will be installed per 1,000 square feet of basement concrete slab. Injection points will be installed via the following:
 - i. Core 6-inch diameter hole through existing slab and remove pre-existing material to a depth of 3 feet below the slab using a vacuum or hand auger. (If the water table is encountered shallow than 3-feet then advance injection point to 1.0 feet above water table)
 - ii. Install stainless steel fittings and ¼ inch Teflon tubing. Backfill with Ottawa sand to 2.5 feet below the slab.
 - iii. Backfill hole around Teflon tubing with hydraulic cement to 4-inches below top of concrete slab.
 - iv. Install 6-inch outer diameter water-tight flush mounted road box into cored hole and hydraulic and cement. Apply elastomeric sealant to road box flare prior to setting road box.
 - v. Apply elastomeric sealant to the top of Portland cement plug inside road box.
 - vi. Float finish Portland cement over existing slab and road box flare to fill gap between slab and road box above elastomeric sealant.
 - vii. Install road box cover with pentagon center bolt and expandable o-ring.

6. Contractor demobilization:

- a. Containerize and dispose of all construction wastes.
- b. Dispose of construction waste off site at a licensed construction waste material disposal facility.
- c. Reinstall and/or replace shelving, non-structural walls/partitions, appliances, etc.
- d. Return temporarily stored items to basement.



Geotechnical
Environmental and
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Appendix M

DNAPL Assessment

**ASSESSMENT OF DNAPL PRESENCE AND DISTRIBUTION
50 TUFTS STREET SITE
SOMERVILLE, MASSACHUSETTS
RTN # 3-23246**

Prepared for:

UniFirst Corporation
10 Jonspin Road
Wilmington, MA

Prepared by:

Bernard H. Kueper
P.Eng., B.A.Sc., Ph.D.
Kingston, Ontario, Canada

1.0 - Introduction

The following work assesses whether dense, non-aqueous phase liquid (DNAPL) is present and how it is distributed in overburden at the 50 Tufts Street Site (Site) in Somerville, Massachusetts. The assessment is carried out for tetrachloroethylene (PCE), trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA), the dominant volatile organic compounds (VOCs) detected in groundwater at the Site. PCE, TCE and TCA are common chlorinated solvent DNAPLs characterized by densities significantly greater than that of water and viscosities similar to that of water. These properties, in conjunction with the fact that it has been several years since potential releases would have occurred and consideration of the operational history of the Site, indicate that any DNAPL in the subsurface would no longer be moving at the present time. It is very likely that any DNAPL present in the subsurface is distributed as both immobile disconnected blobs and ganglia referred to as residual DNAPL, and as continuous static distributions referred to as connected phase DNAPL. Further details regarding the behavior of residual and connected phase DNAPL in both unconsolidated deposits and fractured bedrock is provided by Poulsen and Kueper (1992), Kueper et al. (1993), and Pankow and Cherry (1996).

2.0 - Assessment of DNAPL Presence

The twelve lines of evidence considered in this report can be used to assess whether or not DNAPL is present at a particular site. Satisfying either line of evidence 1 or 2 leads to the conclusion that DNAPL is present. Lines of evidence 3 through 12 could all be negative, yet it must be concluded that DNAPL is present if either lines of evidence 1 or 2 are satisfied.

If lines of evidence 1 and 2 are both negative, it cannot be concluded that DNAPL is not present at a site. It is not uncommon to find sites where lines of evidence 1 and 2 are both negative, yet DNAPL is indeed present in the subsurface (consistent with the popular expression that 'DNAPL is usually not visually observed at a DNAPL site'). In cases where lines of evidence 1 and 2 are both negative, one must consider lines of evidence 3 through 12 and decide if a sufficient number of them are satisfied to conclude whether or not DNAPL is present. This exercise is very site-specific, because geological conditions and contaminant types can vary significantly between sites.

Line of Evidence #1 - Visual Observation

DNAPL obtained from the bottom of a monitoring well, visually observed in drill return water, visually observed in drill cuttings, or visually observed in soil samples/cores is conclusive evidence of DNAPL presence. In cases where the NAPL appears in drill cuttings or soil samples/cores, it may be necessary to perform laboratory analyses (density measurement, component composition measurement) to determine whether the NAPL is lighter (LNAPL) or heavier (DNAPL) than water. Because of the sparse and

tortuous nature of DNAPL distribution in the subsurface, DNAPL is not visually observed at many DNAPL sites.

Evaluation for Tufts Street Site: Negative

Review of drilling logs, reports, and other documents prepared by GEI Consultants, Inc. (GEI), GeoInsight, Inc. and Sanborn Head & Associates concerning subsurface investigations undertaken at the Site indicate that NAPL has never been observed in monitoring wells, soil cores, or drill return water at the Site.

Line of Evidence #2 - Soil Concentrations Above Threshold DNAPL Saturation

Soil concentrations reported by the laboratory that exceed the value corresponding to a threshold DNAPL saturation are conclusive evidence of DNAPL presence. It is recommended that a threshold DNAPL saturation of approximately 5% to 10% of pore space be used in the following calculation.

The soil concentration corresponding to the presence of DNAPL at a specified saturation is given by:

$$C_D = \frac{S_r \phi \rho_N}{\rho_b} + C^T \quad (1)$$

where C_D is the threshold soil concentration, S_r is the specified DNAPL saturation (i.e., 0.05 to 0.10), ϕ is the porosity, ρ_N is the DNAPL density, and ρ_b is the dry soil bulk density. The quantity C^T represents the amount of contaminant present in the soil sample in the aqueous, vapor, and sorbed phases (see Line of Evidence 3 to evaluate C^T). Note, however, that the quantity C^T is typically negligible compared to the DNAPL saturation term. This calculation procedure is applicable to DNAPLs in unconsolidated porous media either above or below the watertable.

**Evaluation for Tufts Street Site: Negative for PCE
Negative for TCE
Negative for TCA**

The term C_D is evaluated here for PCE using $S_r = 0.05$, $\phi = 0.25$, $\rho_N = 1.62$ g/cc (Pankow and Cherry, 1996), $\rho_b = 2.03$ g/cc, and $C^T = 110$ mg/kg (calculated in line of evidence #3 below). This yields a value of $C_D = 10,073$ mg/kg. Examination of available soil data (Figure 1) indicates that the highest PCE concentration measured in soil at the site is 1800 mg/kg in boring SH2(S2A) at a depth of 4-5 ft bgs. This value is below the threshold value of 10,073 mg/kg.

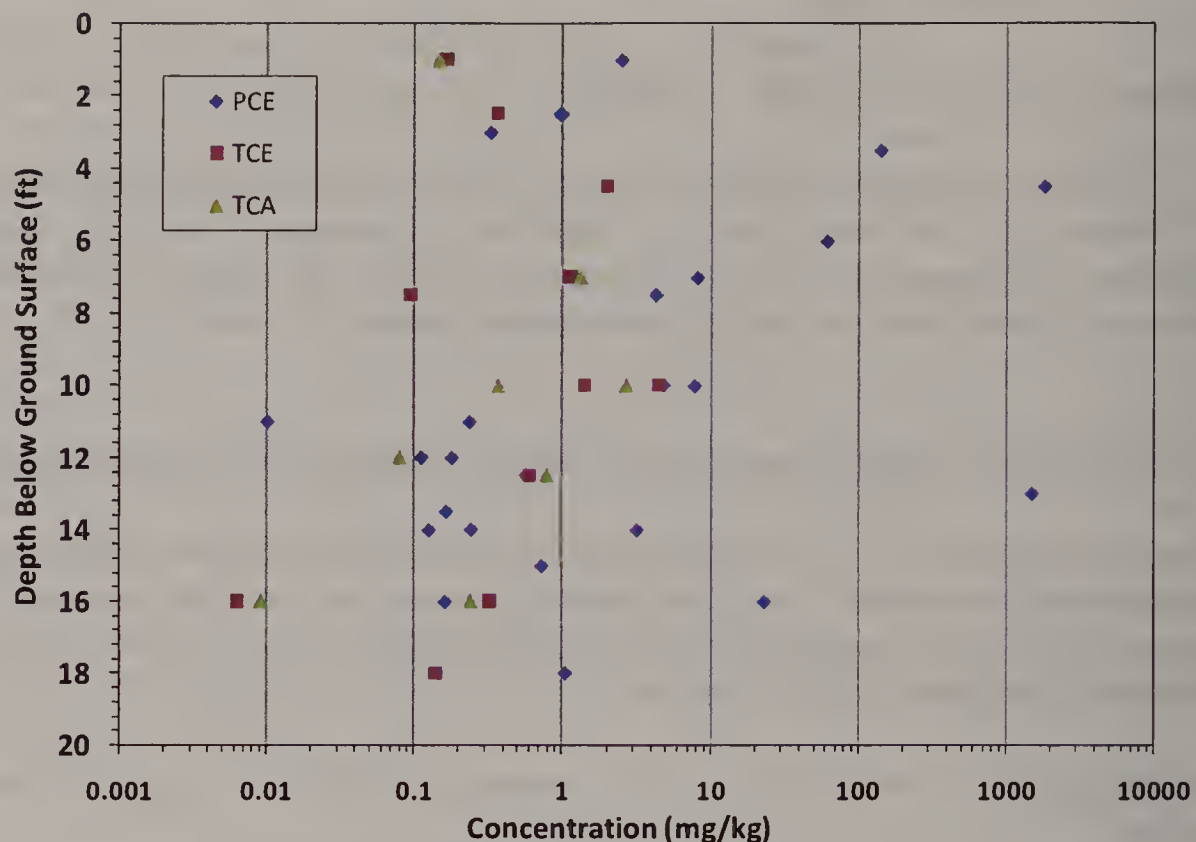


Figure 1 – PCE, TCE and TCA Soil Concentrations versus Depth (non-detect and J values not plotted)

The term C_D is evaluated here for TCE using $S_r = 0.05$, $\phi = 0.25$, $\rho_N = 1.46$ g/cc (Pankow and Cherry, 1996), $\rho_b = 2.03$ g/cc, and $C^T = 389$ mg/kg (calculated in line of evidence #3 below). This yields a value of $C_D = 9,368$ mg/kg. Examination of available soil data (Figure 1) indicates that the highest concentration of TCE detected in soil is 4.4 mg/kg in boring SHB1(S3) at a depth of 10 – 12 ft bgs.

The term C_D is evaluated here for TCA using $S_r = 0.05$, $\phi = 0.25$, $\rho_N = 1.35$ g/cc (Pankow and Cherry, 1996), $\rho_b = 2.03$ g/cc, and $C^T = 556$ mg/kg (calculated in line of evidence #3 below). This yields a value of $C_D = 8,858$ mg/kg. Examination of available soil data (Figure 1) indicates that the highest concentration of TCA detected in soil is 2.7 mg/kg in boring SHB1(S3) at a depth of 8 – 12 ft bgs.

Line of Evidence #3 - Soil Concentrations Above Partitioning Threshold

Soil concentrations exceeding the value corresponding to equilibrium partitioning relationships are evidence of DNAPL presence. The composition of the DNAPL need not be known, and the calculation is applicable to unconsolidated media either above or below the watertable. Measured concentrations that only marginally exceed the calculated threshold can be subject to false positives because of uncertainty associated with estimating the soil-water partition coefficient and other soil parameters.

The soil concentration threshold corresponding to DNAPL presence in a soil sample based on partitioning relationships is given by:

$$C_i^T = \frac{C_i}{\rho_b} (K_d \rho_b + \theta_w + H' \theta_a) \quad (2)$$

where C_i^T is the concentration threshold for component i , C_i is the effective solubility of component i , ρ_b is the dry soil bulk density, K_d is the soil-water partition coefficient, θ_w is the water-filled porosity, H' is the unitless Henry's Law Constant, and θ_a is the air-filled porosity. K_d is often approximated by $K_d = K_{oc} f_{oc}$ where K_{oc} is the organic carbon - water partition coefficient, and f_{oc} is the fraction organic carbon present in the soil. C_i^T represents the maximum amount of contaminant i that can be present in a soil sample in the sorbed, aqueous, and vapour phases without a DNAPL phase present. For a multi-component DNAPL, a separate value of C_i^T would be calculated using the above equation for each component detected in the soil sample.

The above equation makes use of the effective solubility, which is defined as $C_i = m_i S_i$ where C_i is the effective solubility of component i , m_i is the mole fraction of component i in the DNAPL, and S_i is the single-component solubility of component i .

For a multi-component DNAPL, the above calculation procedure requires that the composition of the DNAPL be known a-priori such that the required effective solubilities can be determined. For a multi-component DNAPL of unknown composition, the sum of the mole fractions must equal unity. DNAPL will therefore be present in a soil sample if:

$$\sum_{i=1}^n \frac{C_{obs}^T}{C_S^T} \geq 1 \quad (3)$$

where C_{obs}^T is the reported soil concentration of component i , C_S^T is the single component soil concentration of component i (see above calculation), and n is the number of components observed in the soil sample.

Evaluation for Tufts Street Site: **Positive for PCE**
 Negative for TCE
 Negative for TCA

The above calculation requires site-specific values of the soil fraction organic carbon (f_{oc}). Table 1 summarizes the available measurements with non-detect values set to half of the detection limit. This is justified because it is highly unlikely that any samples would be completely void of naturally occurring organic carbon. As expected, the f_{oc} values are spatially variable at the Site. The sample results are characterized by a minimum value of 0.05% (half the lowest reported detection limit), and a maximum value of 2.82%. The value of 2.82% is uncharacteristically high for the silts and sands

present at the Site. Documentation produced by GEI indicates that the value of 2.82% corresponds to coal ash encountered in fill material during drilling. Consequently, this value will be disregarded in this analysis. The arithmetic mean value, excluding the 2.82% value, is 0.285% which is typical of silt and sand deposits.

Table 1 – Summary of Soil Fraction Organic Carbon Measurements

Boring	Value (mg/kg)	Value (mg/kg)	Value (-)	Value (%)
B100	1630	1630	0.00163	0.163
B106(12-14)	<1100	550	0.00055	0.055
B106(16-18)	<1100	550	0.00055	0.055
B106 VAC COMP	28200	28200	0.0282	2.82
B107(20-21)	<1000	500	0.0005	0.05
B107(7-9)	<1300	650	0.00065	0.065
B107-VAC COMP	4090	4090	0.00409	0.409
B108(7-8)	6650	6650	0.00665	0.665
B108-VAC COMP	4430	4430	0.00443	0.443
B109(13-15)	<1100	550	0.00055	0.055
B109(7-9)	4620	4620	0.00462	0.462
B109-VAC COMP	5580	5580	0.00558	0.558
B110(13-14)	<1100	550	0.00055	0.055
B110(7-9)	3660	3660	0.00366	0.366
B110-VAC COMP	4380	4380	0.00438	0.438
B111(13-15)	<1100	550	0.00055	0.055
B111(7-9)	<1200	600	0.0006	0.06
B111-VAC COMP	<1000	500	0.0005	0.05
B112(6-7)	<1300	650	0.00065	0.065
B112-VAC COMP	4600	4600	0.0046	0.46
B117D-S2	4780	4780	0.00478	0.478
B118D-S2	9760	9760	0.00976	0.976

The term C^T (equation 2) is evaluated here for PCE (assuming a single component DNAPL) using $C_i = 200$ mg/l (TRRP, 2005), $\rho_b = 2.03$ g/cc, $K_{oc} = 154.9$ ml/g (TRRP, 2005), $f_{oc} = 0.00285$ (average of site-specific values), $\theta_w = 0.125$, $\theta_a = 0.125$, and $H' = 0.765$ (TRRP, 2005). This yields a value of $C^T = 110$ mg/kg. Examination of all

available soil quality data presented in Figure 1 indicates that this threshold was exceeded in boring SH1(S4) [1500 mg/kg] at a depth of 12 – 14 ft bgs, in boring SH2(S2A) [1800 mg/kg] at a depth of 4 – 5 ft bgs, and in boring SH3(S1D) [140 mg/kg] at a depth of 3 – 4 ft bgs. Boring SH1 is located inside the 50 Tufts Street building (southern portion) along the western wall. Boring SH2 is located inside the 50 Tufts Street building (northern portion) along the western wall. Boring SH3 is located inside the 50 Tufts Street building (northern portion) along the eastern wall.

It should be noted that the values of C^T calculated using equation (2) are relatively insensitive to water and air content. Setting the water filled porosity equal to the total porosity (0.25) and the air filled porosity to zero, for example, yields a C^T value equal to 113 mg/kg for PCE. This value would be applicable to samples collected from below the watertable, and it can be seen that it is similar to that calculated using a water filled porosity of 0.125 and an air filled porosity of 0.125.

Of all the site-specific input parameters provided to equation (2), the value of C^T is most sensitive to the soil fraction organic carbon (f_{oc}). Using the lowest (0.0005) and highest (0.00665) values of f_{oc} considered yields C^T values (calculated using $\theta_w = 0.125$ and $\theta_a = 0.125$) for PCE of 37 mg/kg and 228 mg/kg, respectively. The value of 37 mg/kg is exceeded in the three samples discussed above, as well as in SH5(S2) [61 mg/kg] at a depth of 4 – 8 ft bgs. Boring SH5 is located inside the 50 Tufts Street building (southern portion) along the interior northern wall.

The term C^T (equation 2) is evaluated here for TCE (assuming a single component DNAPL) using $C_i = 1100$ mg/l (TRRP, 2005), $\rho_b = 2.03$ g/cc, $K_{oc} = 93.3$ ml/g (TRRP, 2005), $f_{oc} = 0.00285$ (average of site-specific values), $\theta_w = 0.125$, $\theta_a = 0.125$, and $H' = 0.428$ (TRRP, 2005). This yields a value of $C^T = 389$ mg/kg. Examination of all available soil quality data presented in Figure 1 indicates that this threshold was not exceeded in any of the available soil samples.

Setting the water filled porosity equal to the total porosity (0.25) and the air filled porosity to zero yields a C^T value equal to 428 mg/kg for TCE. This value would be applicable to samples collected from below the watertable, and it can be seen that it is similar to that calculated using a water filled porosity of 0.125 and an air filled porosity of 0.125. Using the lowest (0.0005) and highest (0.00665) values of f_{oc} considered yields C^T values (calculated using $\theta_w = 0.125$ and $\theta_a = 0.125$) for TCE of 148 mg/kg and 779 mg/kg, respectively. The value of 148 mg/kg is not exceeded in any of the reported soil samples.

The term C^T (equation 2) is evaluated here for TCA (assuming a single component DNAPL) using $C_i = 1330$ mg/l (TRRP, 2005), $\rho_b = 2.03$ g/cc, $K_{oc} = 109.6$ ml/g (TRRP, 2005), $f_{oc} = 0.00285$ (average of site-specific values), $\theta_w = 0.125$, $\theta_a = 0.125$, and $H' = 0.715$ (TRRP, 2005). This yields a value of $C^T = 556$ mg/kg. Examination of all available soil quality data presented in Figure 1 indicates that this threshold was not exceeded in any of the available soil samples.

Setting the water filled porosity equal to the total porosity (0.25) and the air filled porosity to zero yields a C^T value equal to 579 mg/kg for TCA. This value would be applicable to samples collected from below the watertable, and it can be seen that it is similar to that calculated using a water filled porosity of 0.125 and an air filled porosity of 0.125. Using the lowest (0.0005) and highest (0.00665) values of f_{oc} considered yields C^T values (calculated using $\theta_w = 0.125$ and $\theta_a = 0.125$) for TCA of 213 mg/kg and 1110 mg/kg, respectively. The value of 213 mg/kg is not exceeded in any of the reported soil samples.

Line of Evidence #4 – Contiguous and Persistent Zone of Concentrations in Groundwater Extending in Downgradient Direction

A contiguous zone in which constituents of concern persist in groundwater in the downgradient direction is indicative of the presence of DNAPL in the subsurface. If ‘sufficient time’ has passed since the last possible introduction of DNAPL to the subsurface and the zone has not ‘detached’ itself from the suspected release locations, DNAPL may be present. The ‘sufficient time’ is dependent on site-specific conditions. This line of evidence can be inconclusive in environments characterized by low hydraulic conductivity values, low hydraulic gradients, highly sorbing compounds, and geology subject to significant amounts of back-diffusion (e.g., fractured bedrock with a porous matrix, fractured clay) since all of these factors can delay detachment even when DNAPL is not present. A screening level evaluation of the time taken for a zone of affected groundwater to detach is given by:

$$t = \frac{LR}{v} \quad (4)$$

where t is the detachment time, L is the length of the suspected source zone in the direction of groundwater flow, R is the retardation factor, and v is the average linear groundwater velocity approximated as:

$$v = -\frac{K\nabla h}{\phi} \quad (5)$$

where K is the hydraulic conductivity, ∇h is the hydraulic gradient, and ϕ is the porosity. The retardation factor (R) is given by:

$$R = 1 + \frac{\rho_b}{\phi} K_{oc} f_{oc} \quad (6)$$

where ρ_b is the soil dry bulk density, ϕ is the porosity, K_{oc} is the organic-carbon partition coefficient, and f_{oc} is the fraction organic carbon.

**Evaluation for Tufts Street Site: Positive for PCE
Positive for TCE
Positive for TCA**

The retardation factor (R) required in the evaluation of equation (4) is calculated here for PCE using $\rho_b = 2.03$ g/cc, $\phi = 0.25$, $K_{oc} = 154.9$ ml/g (TRRP, 2005), and $f_{oc} = 0.00285$ (average of measured values). This yields an average value of $R = 4.59$. The practical implication of this is that the PCE will travel approximately five times slower than the groundwater considering advection alone. Using the minimum (0.0005) and maximum (0.00665) values of f_{oc} yields retardation factors of 1.63 and 9.37, respectively.

For TCE, the retardation factor is calculated using $\rho_b = 2.03$ g/cc, $\phi = 0.25$, $K_{oc} = 93.3$ ml/g (TRRP, 2005), and $f_{oc} = 0.00285$ (average of measured values). This yields an average value of $R = 3.16$. Using the minimum (0.0005) and maximum (0.00665) values of f_{oc} yields retardation factors of 1.38 and 6.05, respectively.

For TCA, the retardation factor is calculated using $\rho_b = 2.03$ g/cc, $\phi = 0.25$, $K_{oc} = 109.6$ ml/g (TRRP, 2005), and $f_{oc} = 0.00285$ (average of measured values). This yields an average value of $R = 3.54$. Using the minimum (0.0005) and maximum (0.00665) values of f_{oc} yields retardation factors of 1.45 and 6.93, respectively.

Table 2 lists the available hydraulic conductivity measurements for the Site and surrounding area. The values range from a low of 1.68E-05 cm/s (GEO-6) to a high of 6.13E-02 cm/s (MW-119T). This range of values is indicative of a moderate to high degree of overburden heterogeneity.

The values of hydraulic conductivity have been grouped according to north and south designations. Evaluation of groundwater quality data indicates that is useful to identify both a north and a south VOC zone. The north zone is assumed to extend downgradient from the general vicinity of GEO-1 and MW-1 in the northern portion of the Site. The south zone is assumed to extend downgradient from the general vicinity of SH-1 and MW-3 in the central to southern portion of the Site.¹ The geometric mean hydraulic conductivities of both the north and south zones are presented in Table 3 (excluding the two bedrock values).

Figure 2 presents a summary of hydraulic gradients calculated using waterlevel data collected between October 2006 and September 2007. The arithmetic mean hydraulic gradient for the north zone is calculated to be 0.0115. The last three plotted points for the south zone make use of waterlevel data from MW-118S (not available for prior dates), which is located significant distance from the other south zone water level measuring points. Excluding these last three plotted points (not suitable for a detachment

¹ The distribution of constituents in groundwater (e.g., from Morton Street to the northeast) may reflect additional historical releases cross-gradient from 50 Tufts Street. This assessment proceeds on the assumption that there are continuous northern and southern zones extending in groundwater from the 50 Tufts Street property solely for purposes of simplifying this assessment and evaluating the potential presence and distribution of DNAPL associated with RTN # 3-23246.

assessment) and the first plotted point (which appears to be an outlier), the arithmetic mean hydraulic gradient for the south zone is calculated to be 0.0143. The arithmetic mean hydraulic gradients used for the detachment assessment are listed in Table 3.

Table 2 – Summary of Hydraulic Conductivity Measurements

Well Name	Geology	K (cm/s)	Zone
GEO-1	Overburden	2.21E-03	N
GEO-2	Overburden	1.57E-03	N
GEO-3	Overburden	5.13E-05	N
GEO-5	Overburden	9.82E-05	S
GEO-6	Overburden	1.68E-05	S
MW-101	Overburden	8.21E-04	N
MW-102	Overburden	6.33E-05	N
MW-111	Overburden	5.87E-03	S
MW-112A	Overburden	1.05E-04	N
MW116	Bedrock	2.20E-02	N
MW117S	Overburden	4.72E-05	S
MW117T	Till	4.46E-04	S
MW118S	Overburden	1.22E-02	S
MW118T	Till	1.44E-03	S
MW119S	Overburden	3.67E-02	N
MW119T	Till	6.13E-02	N
MW120D	Bedrock	5.42E-04	N
MW121S	Overburden	7.51E-03	N
MW-201	Overburden	6.82E-03	N
MW-202	Overburden	2.76E-03	N
SH-MW3	Overburden	4.47E-04	S

NOTE: Arithmetic mean K value listed where two tests performed in a well

Table 3 – Summary of Geometric Mean Hydraulic Conductivity Values and Hydraulic Gradients

North Zone	South Zone
Grad H = 0.0115	Grad H = 0.0143
$K_{geo} = 1.68E-03$ cm/s	$K_{geo} = 4.47E-04$ cm/s
n = 11 slug test values	n = 8 slug test values

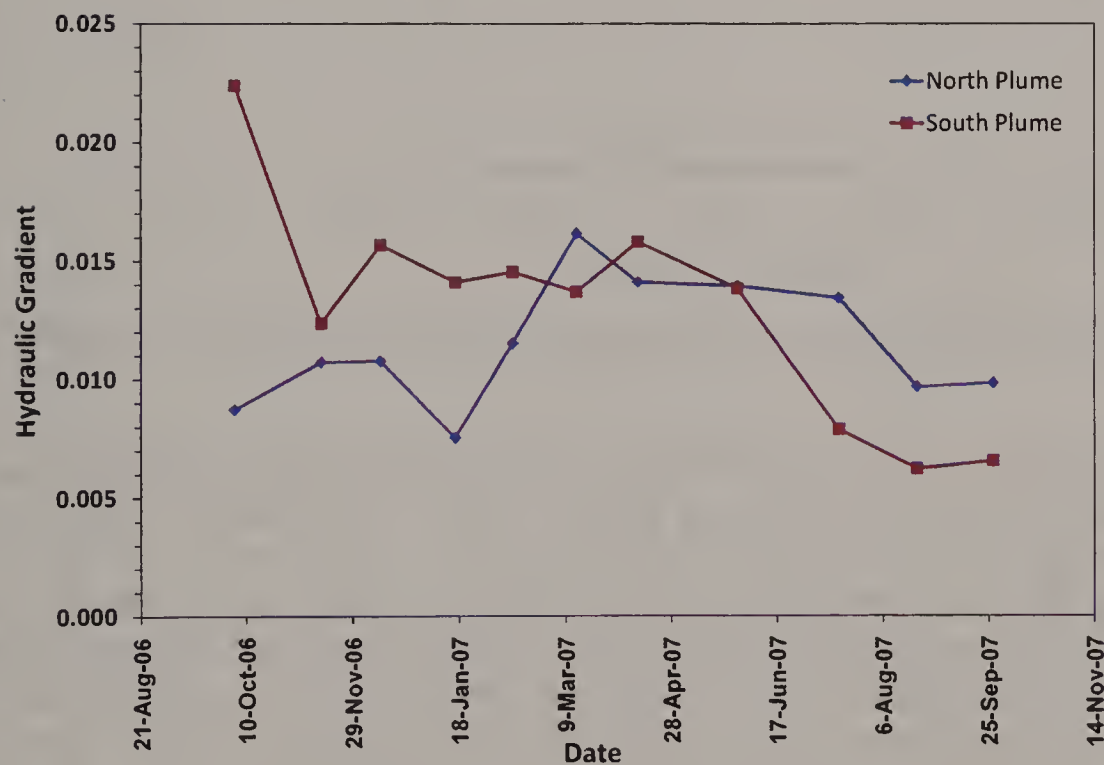


Figure 2 – Summary of Hydraulic Gradients

Using a hypothetical source zone length of 100 ft, the hydraulic conductivity and hydraulic gradient values presented in Table 3, an effective porosity of 0.25, and a retardation factor of 4.59, the resulting PCE detachment times (t) calculated using equation (4) for the north and south zones are 5.74 yrs and 17.35 yrs, respectively. The calculated TCE detachment times (using a retardation factor of 3.16) for the north and south zones are 3.96 yrs and 11.95 yrs, respectively. The calculated TCA detachment times (using a retardation factor of 3.54) for the north and south zones are 4.43 yrs and 13.38 yrs, respectively.

Figures 3 and 4 present plots of PCE concentration versus distance for the north and south zones, respectively. These figures present all groundwater sampling results available up to July, 2007. It is clear from both figures that the highest concentrations occur in the vicinity of the assumed source areas and that the zones have not detached themselves from their sources. If it is assumed that releases have not occurred at the Site during the past twenty years, the calculated PCE detachment times indicate that the persistent high concentrations of PCE in groundwater are attributable to the presence of DNAPL. If it is assumed that releases have not occurred at the Site during the past ten years, the calculated PCE detachment times indicate that the persistent high concentrations of PCE in groundwater are attributable to the presence of DNAPL in the northern portion of the Site, but the analysis would be inconclusive for the southern portion of the Site.

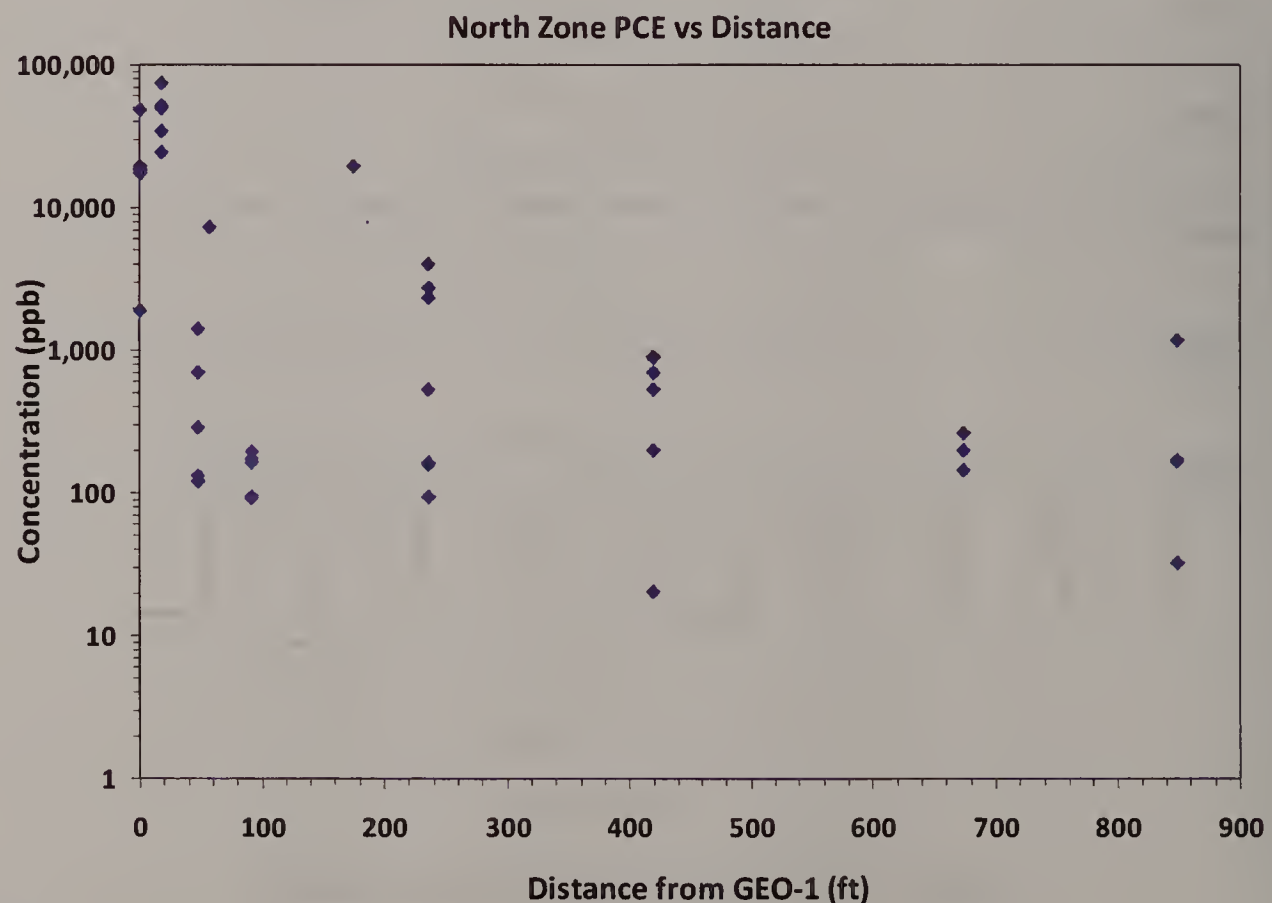


Figure 3 – North Zone PCE Concentration in Groundwater versus Distance

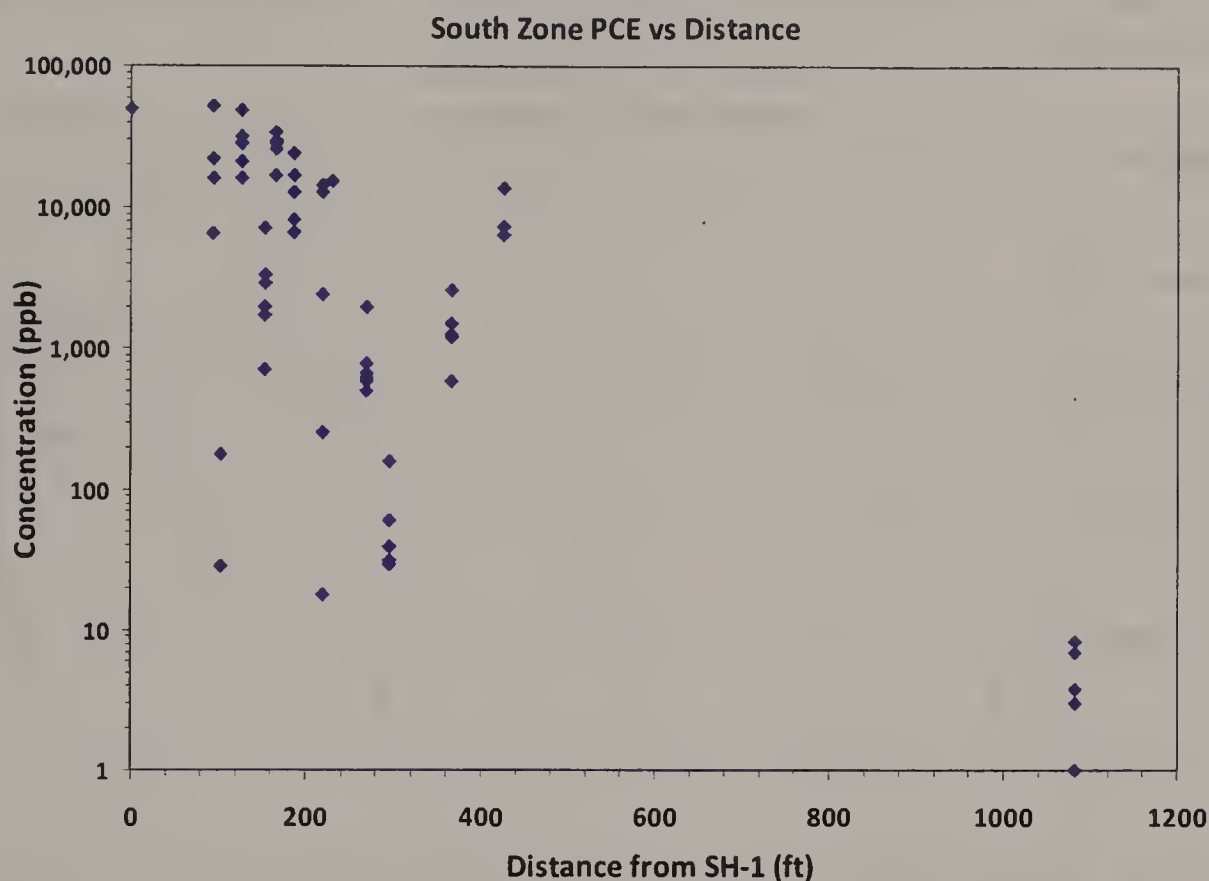


Figure 4 – South Zone PCE Concentration in Groundwater versus Distance

Figures 5 and 6 present plots of TCE concentration versus distance for the north and south zones, respectively. These figures present all groundwater sampling results available up to July, 2007. It is clear from both figures that the highest concentrations occur in the vicinity of the assumed source areas and that the zones have not detached themselves from their sources. If it is assumed that releases have not occurred at the Site during the past twenty years, the calculated TCE detachment times indicate that the persistent high concentrations of TCE in groundwater are attributable to the presence of DNAPL. If it is assumed that releases have not occurred at the Site during the past ten years, the calculated TCE detachment times indicate that the persistent high concentrations of TCE in groundwater are attributable to the presence of DNAPL in the northern portion of the Site, but the analysis would be inconclusive for the southern portion of the Site.

Figures 7 and 8 present plots of TCA concentration versus distance for the north and south zones, respectively. These figures present all groundwater sampling results available up to July, 2007. It is clear from both figures that the highest concentrations occur in the vicinity of the assumed source areas and that the zones have not detached themselves from their sources. If it is assumed that releases have not occurred at the Site during the past twenty years, the calculated TCA detachment times indicate that the persistent high concentrations of TCA in groundwater are attributable to the presence of DNAPL. If it is assumed that releases have not occurred at the Site during the past ten years, the calculated TCA detachment times indicate that the persistent high concentrations of TCA in groundwater are attributable to the presence of DNAPL in the

northern portion of the Site, but the analysis would be inconclusive for the southern portion of the Site.

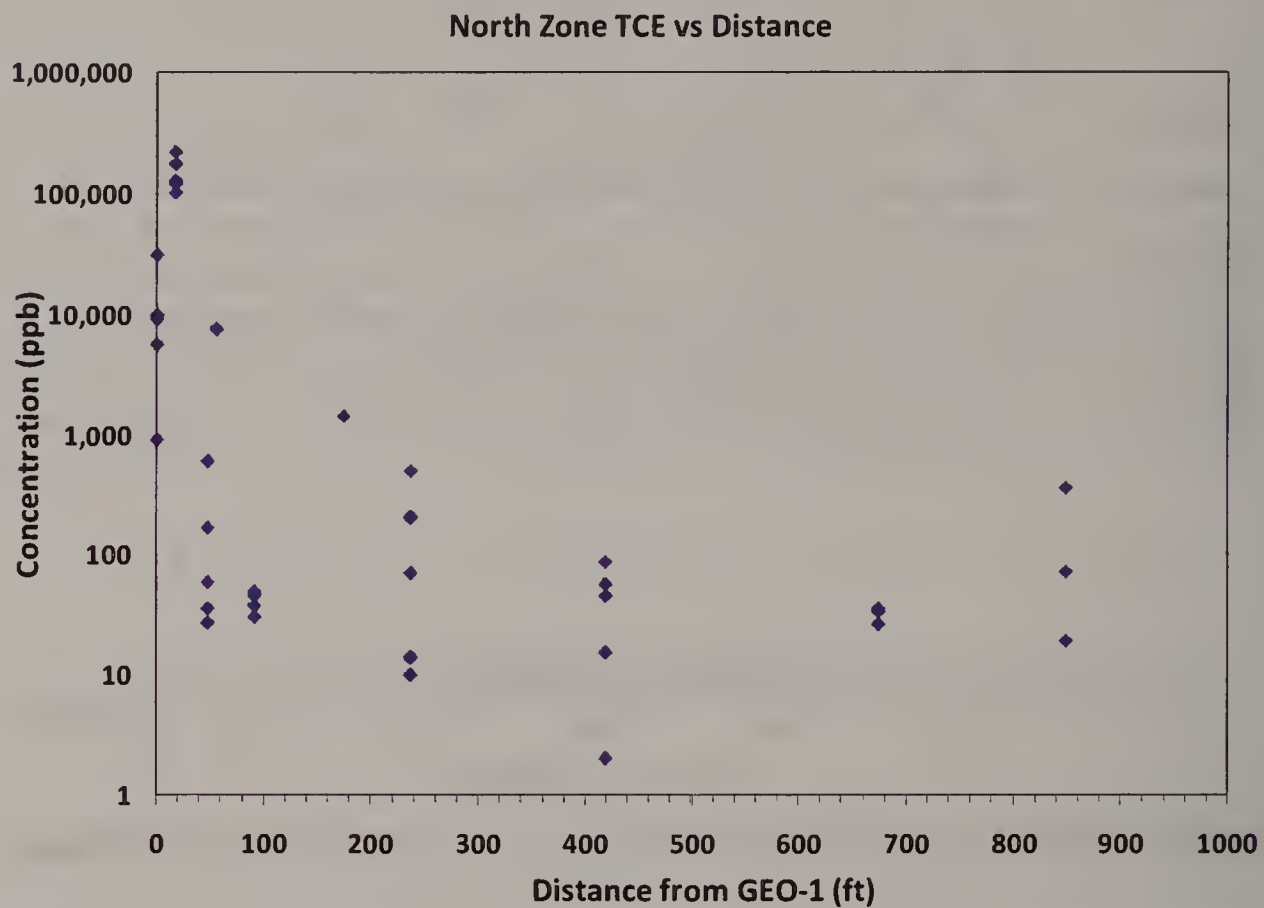


Figure 5 – North Zone TCE Concentration in Groundwater versus Distance

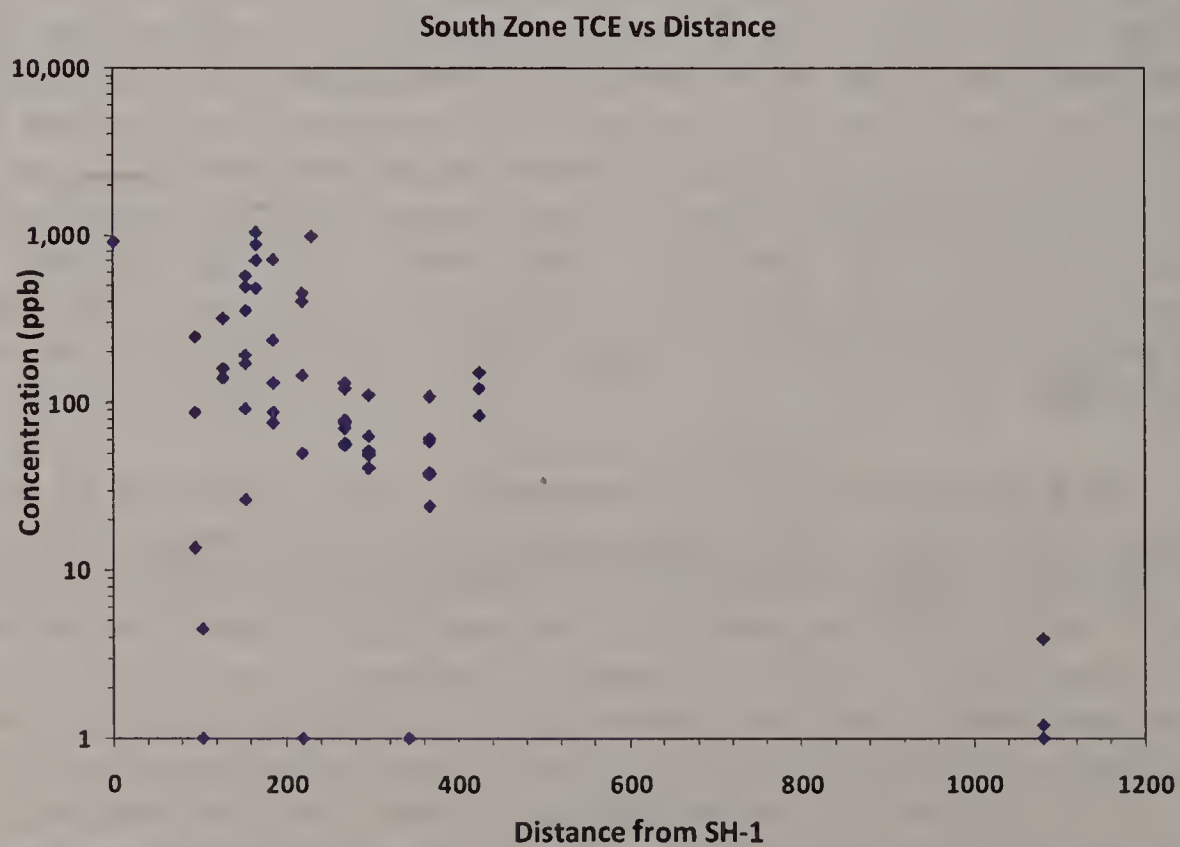


Figure 6 – South Zone TCE Concentration in Groundwater versus Distance

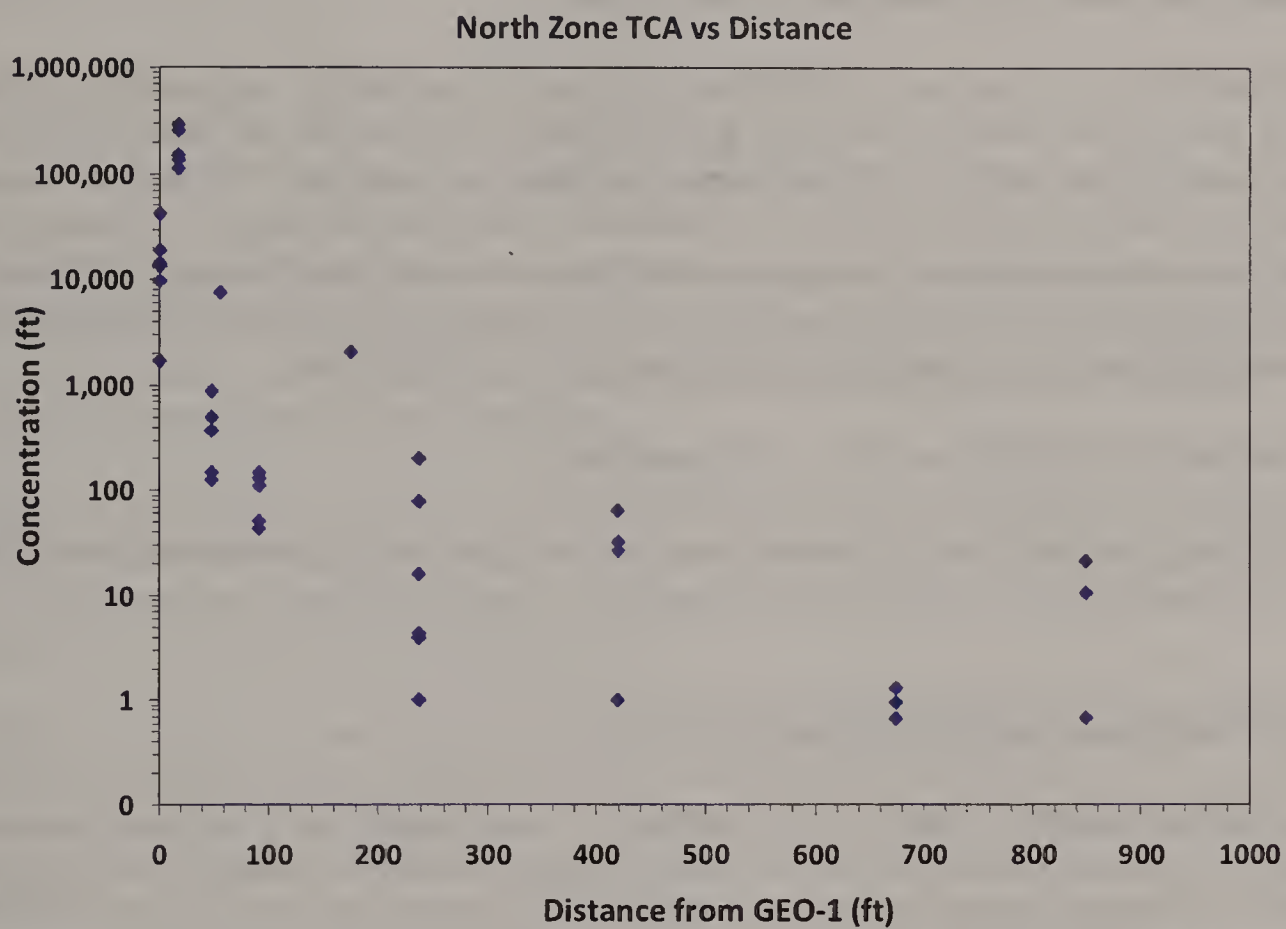


Figure 7 – North Zone TCA Concentration in Groundwater versus Distance

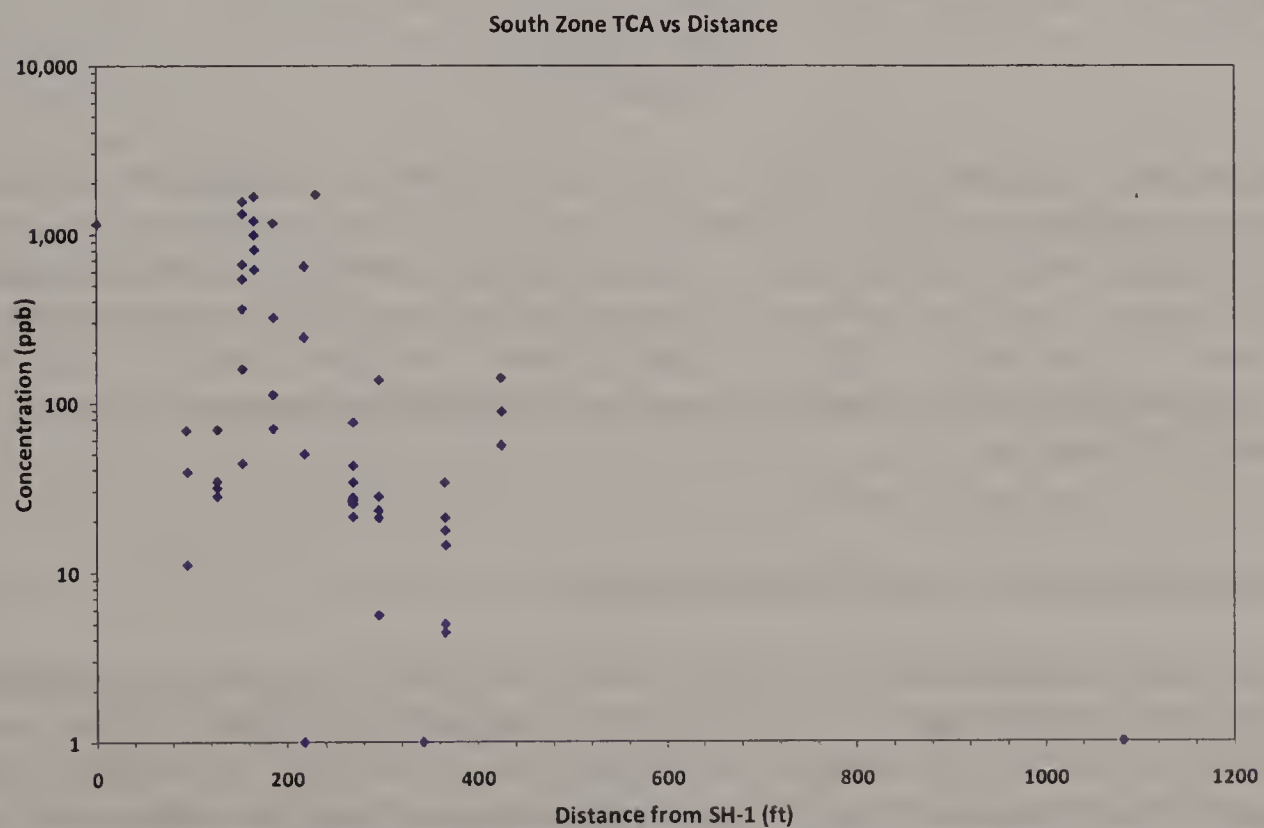


Figure 8 – South Zone TCA Concentration in Groundwater versus Distance

Line of Evidence #5 - Hydrophobic Dye Testing

Hydrophobic dye techniques include the jar shake test in which a soil sample is placed into a jar with a small amount of dye (typically Oil Red O, or Sudan IV), dye-impregnated paper towels that are wrapped around soil samples followed by manual squeezing, and down-hole samplers. It should be noted that the absence of staining on a down-hole ribbon sampler is not evidence of the absence of DNAPL, since only pooled DNAPL can migrate towards the sampler (residual DNAPL may be present in the formation adjacent to the sampling interval, and remain undetected).

Evaluation for Tufts Street Site: Not applicable

Hydrophobic jar shake tests have not been employed as part of drilling activities at the Site.

Line of Evidence #6 - Site Use/Site History

Investigations carried out in various countries throughout the world during the past 20 years have shown that the subsurface occurrence of DNAPL is often times associated with the industries, practices, and processes that are known to have utilized DNAPLs (e.g., PCE associated with dry cleaning, TCE associated with metal degreasing, coal tar associated with MGP, etc). Site Use/Site History can be ascertained using methods such as employee interviews, company purchase and sale records, and aerial photographs.

**Evaluation for Tufts Street Site: Positive for PCE
Positive for TCE
Positive for TCA**

Documentation submitted to MADEP concerning the history of operations at 50 Tufts Street has confirmed that PCE, TCE and TCA in DNAPL form were stored and handled there for many years. The property was used for approximately 50 years as a laundry supply business. Delivery, storage, loading and unloading of PCE has been documented for much of that period. Likewise, piping labels and other historical information indicates that TCE and TCA were delivered, stored, loaded and unloaded on the northern portion of the property.

Line of Evidence #7 - Vapor Concentrations

Sampled vapor concentrations in excess of 10% effective vapor solubility calculated using either the ideal gas law or the Henry's constant, and adjusted in the case of multicomponent DNAPLs using Raoult's law, are an indication of possible DNAPL presence in the unsaturated zone. Vapor concentrations will decrease with distance away from DNAPL locations, and will decrease with time after all DNAPL has vaporized itself

away. Therefore, the simple presence of contaminant vapors is not conclusive evidence of DNAPL presence.

Evaluation for Tufts Street Site: **Negative for PCE**
 Negative for TCE
 Negative for TCA

Using a PCE Henry's constant of 0.765 (TRRP, 2005) and an aqueous solubility of 200 mg/l, the equilibrium vapor solubility of PCE is calculated to be 153 mg/l. Using 10% of this value provides a threshold vapor concentration of 15.3 mg/l. No subsurface vapor samples have exceeded this concentration.

Using a TCE Henry's constant of 0.428 (TRRP, 2005) and an aqueous solubility of 1100 mg/l, the equilibrium vapor solubility of TCE is calculated to be 471 mg/l. Using 10% of this value provides a threshold vapor concentration of 47.1 mg/l. No subsurface vapor samples have exceeded this concentration.

Using a TCA Henry's constant of 0.715 (TRRP, 2005) and an aqueous solubility of 1330 mg/l, the equilibrium vapor solubility of TCA is calculated to be 951 mg/l. Using 10% of this value provides a threshold vapor concentration of 95.1 mg/l. No subsurface vapor samples have exceeded this concentration.

Line of Evidence #8 - Magnitude of Groundwater Concentrations

Sampled groundwater concentrations in excess of 1% effective solubility indicate that DNAPL may be present upgradient of the monitoring point in question. The upgradient distance to the possible DNAPL locations cannot be determined from the magnitude of the concentration alone. Sampled groundwater concentrations downgradient of a DNAPL zone are significantly less than the effective solubility because of hydrodynamic dispersion, wellbore dilution, non-optimal monitoring well placement, and degradation processes. In cases where significant degradation is occurring, daughter product concentrations can be converted to equivalent parent product concentrations before comparing to the 1% effective solubility threshold.

For a multicomponent DNAPL where the composition is not known, the following can be applied. Assuming that the degree of borehole dilution, dispersion, and degradation is identical for each component of interest in an obtained groundwater sample, the

summation $\sum \frac{C_i^{obs}}{S_i} = \alpha$ can be calculated where C_i^{obs} is the sampled groundwater

concentration of component i , S_i is the single-component solubility of component i , and α is the cumulative mole fraction of the sample. If the 1% rule-of-thumb is adopted, it follows that DNAPL may be present upgradient of a monitoring well if $\alpha > 0.01$. The procedure can be applied on a sample-by-sample basis without having to make the assumption that the DNAPL composition is spatially uniform in the subsurface. If it is believed that 5% effective solubility indicates DNAPL presence, α can be set to 0.05.

**Evaluation for Tufts Street Site: Positive for PCE
Positive for TCE
Positive for TCA**

Assuming that PCE exists as a single component DNAPL, the 1% effective solubility value is 2 mg/l. Assuming that TCE exists as a single component DNAPL, the 1% effective solubility value is 11 mg/l. Assuming that TCA exists as a single component DNAPL, the 1% effective solubility value is 13.3 mg/l. Table 4 summarizes the monitoring wells that have exceeded these thresholds.

Table 4 – Summary of Monitoring Wells That Have Exceeded 1% Solubility of PCE, TCE and TCA

PCE		TCE		TCA	
North	South	North	South	North	South
GEO-1	SH-1	GEO-1	none	GEO-1	none
MW-1	MW-3	MW-1		MW-1	
SH-4	SHMW-1				
SH-3	SHMW-2				
GEO-3	SHMW-3				
	GEO-4				
	GEO-5				
	MW-203				
	MW-103				
	MW-111				

Line of Evidence #9 - Presence of Contamination in Hydraulically Anomalous Locations

The presence of contaminated groundwater in locations that do not have flow lines leading directly to near surface sources is evidence of DNAPL presence hydraulically upgradient of the monitoring point in question. An example includes the presence of contamination at depth in a horizontally flowing system. This line of evidence is not contingent on any concentration threshold.

Evaluation for Tufts Street Site: Positive

Overburden deposits at the Site are relatively thin and groundwater flow directions are primarily horizontal. Given the orientation of the Site relative to groundwater flow, it can be concluded that the high concentrations of VOCs in GEO-1, MW-1, SH-1 and SHMW-

2 are consistent with the presence of DNAPL given the locations of these wells along the upgradient edge of the 50 Tufts Street property.

Line of Evidence # 10 - Concentration Reversals with Depth

The presence of groundwater concentration reversals with depth, or increasing concentrations with depth, can be associated with DNAPL presence. A somewhat erratic distribution of aqueous phase concentrations may reflect the architecture of a DNAPL zone.

Evaluation for Tufts Street Site: Not Applicable

Overburden deposits at the Site are relatively thin. As a result, on site groundwater monitoring wells have not been placed at multiple depths. Consequently, detailed analysis of concentration trends as a function of depth cannot be carried out.

Line of Evidence #11 – Multicomponent Groundwater Concentration Trends

Groundwater concentrations downgradient of a multicomponent DNAPL may exhibit a decline in time of the higher effective solubility compounds and a stable or increasing trend in time of the lower effective solubility compounds. This line of evidence is primarily applicable to mixed DNAPLs.

Evaluation for Tufts Street Site: Not applicable

Although PCE, TCE and TCA are present in the subsurface at similar locations, site use/site history information suggests that these chemicals were handled and stored separately. The conceptual model is that separate releases of each of these chemical may have occurred. This does not preclude the comingling of the various DNAPLs in the subsurface, but insufficient data (e.g., DNAPL mole fractions, timing of releases) exists at present to consider a multicomponent based concentration versus time trend analysis.

Line of Evidence #12 - Partitioning Interwell Tracer Tests

A partitioning interwell tracer test (PITT) can be used to establish the possible presence of DNAPL. These tests work best in well defined, moderate to high permeability flow systems and geological environments not susceptible to matrix diffusion.

Evaluation for Tufts Street Site: Not applicable

PITT tests have not been employed at the Tufts Street Site.

2.0- Summary of DNAPL Assessment Lines of Evidence

Table 5 summarizes the results of evaluating the above 12 lines of evidence for DNAPL presence at the Site. It is concluded that DNAPL is present in overburden on the basis of a converging lines of evidence approach. The most compelling lines of evidence are associated with the persistent, high groundwater concentrations in the vicinity of areas where it is known that chlorinated solvents were stored and handled.

**Table 5 – Summary of Lines of Evidence Used to Assess DNAPL Presence
(blank entry implies test not utilized and/or not applicable)**

Line of Evidence	PCE	TCE	TCA
1 – Visual Observation	neg	neg	neg
2 – Soil Above DNAPL Saturation	neg	neg	neg
3 – Soil Above Partitioning Threshold	pos	neg	neg
4 – Zone Attached to Source	pos	pos	pos
5 – Dye Testing			
6 – Site Use/History	pos	pos	pos
7 – Vapour Concentrations	neg	neg	neg
8 – Groundwater Above 1% Effective Solubility	pos	pos	pos
9 – Contamination in Anomalous Locations	pos	pos	pos
10 – Concentration Reversals with Depth			
11 – Multicomponent Concentration Trends			
12 – PITT Testing			

neg = negative, pos = positive

3.0 – Distribution of DNAPL

DNAPL is present in overburden down to the top of bedrock (and possibly in bedrock) at the Site. The DNAPL is not present continuously throughout this volume of porous media, but is rather situated in many discrete lenses and laminations of geologic material. It is not practicable to find the particular lenses and laminations that contain DNAPL. DNAPL has not been visually observed in any monitoring well or in any groundwater or soil sample. Given the lack of DNAPL accumulation in monitoring wells, it can be concluded that the majority of DNAPL exists in the form of disconnected blobs and ganglia of organic liquid referred to as residual DNAPL. Residual DNAPL is immobile as a result of capillary trapping forces. In addition to residual DNAPL, it is possible that isolated zones of continuous DNAPL also exist at the Site. Given the relatively high density and low viscosity of PCE, TCE and TCA along with the moderate hydraulic conductivity of the overburden deposits, it can be concluded that any continuous distributions of DNAPL are no longer migrating and have been stabilized by capillary trapping forces.

With respect to spatial distribution, it is highly likely that DNAPL is present at various locations beneath the entire 50 Tufts Street building footprint. Releases likely occurred at various locations where solvents were stored and handled with subsequent subsurface migration along geological bedding planes and conduit backfill facilitating spreading to various locations beneath the entire building footprint.

The DNAPL extends into the northern parking lot area beyond monitoring well GEO-1, but not as far as monitoring wells MW-202 and MW-201. This interpretation is supported by the fact that groundwater concentrations in GEO-1 have been as high as 121,000 ppb (sum of PCE, TCE and TCA), yet concentrations in MW-202 and MW-201 have not exceeded 64 ppb (sum of PCE, TCE and TCA). This abrupt drop in concentrations in the hydraulically up gradient direction indicates that the northern extent of the DNAPL lies between monitoring wells GEO-1 and MW-202.

It is highly likely that DNAPL is present east of the Site beneath Tufts Street from a location south of MW-101 to approximately the location of GEO-5, and that it extends from the Site to beneath properties on the east side of Tufts Street in the vicinity of monitoring well GEO-4. The presence of DNAPL beneath these Tufts Street properties is supported by the persistent high groundwater concentrations in monitoring wells GEO-4 and GEO-5. It is possible that DNAPL extends beneath other properties east of Tufts Street.

It is highly likely that DNAPL is present south of the building footprint, extending to approximately the location of SHMW-2 and possibly further to the south. This interpretation is supported by the persistent high concentrations in monitoring wells MW-3, SH-MW1, SH-MW3 and SH-MW2, and the high concentration of PCE in monitoring well MW-203 (15,500 ppb). It is highly likely that DNAPL is present in overburden west of the 50 Tufts Street building footprint (off-site on railway property). This interpretation is supported by the high concentrations in monitoring wells GEO-1, MW-1 and SH-1 which are located along the western boundary of the 50 Tufts Street property adjacent to the railway property.

With respect to DNAPL composition, it can be concluded that the northern portion of the Site is impacted by PCE DNAPL, TCE DNAPL and TCA DNAPL. PCE, TCE and TCA have been detected in groundwater in the northern portion of the site at up to 37.5%, 20% and 21.8% of single component solubility, respectively. The southern portion of the Site is impacted by PCE DNAPL, with PCE concentrations in groundwater as high as 25.9% of single component solubility. TCE and TCA concentrations in groundwater in the southern portion of the Site have not exceeded 0.09% and 0.13% of single component solubility, respectively. The persistent presence of TCE and TCA in groundwater indicates that minor quantities of TCE and TCA DNAPL may be present in the southern portion of the Site.

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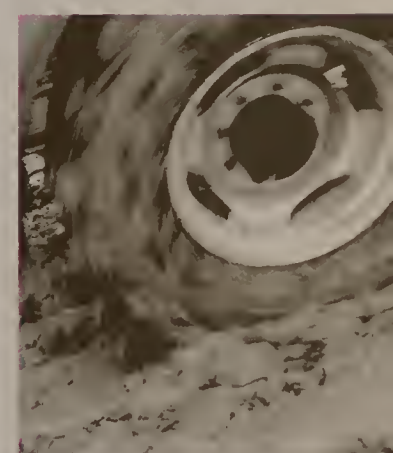
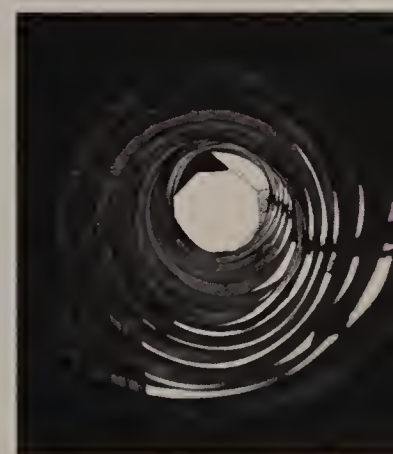
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TRRP – Texas Risk Reduction Program, 2005. Table of chemical and physical properties.



Geotechnical
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Appendix N

Method 3 Risk Characterization

**Method 3 Risk Characterization
50 Tufts Street, Somerville, MA
UniFirst Corporation**

Prepared by:

AMEC Earth & Environmental
Westford, Massachusetts

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EXECUTIVE SUMMARY

This Appendix presents the results of a Method 3 Risk Characterization for potential exposure pathways associated with RTN 3-23246. The Risk Characterization evaluates conditions at the property at 50 Tufts Street in Somerville, Massachusetts (the Property), portions of properties in the neighborhood east and west of the Property, and the Michael E. Capuano Early Childhood Center (the Capuano Center) located at 150 Glen Street in Somerville, Massachusetts. These areas collectively define the "Site" for this Risk Characterization.

This Risk Characterization supports the Phase II Comprehensive Site Assessment (Phase II CSA) and is not intended to be a stand-alone document. It summarizes, where applicable, information on Site characterization and MCP compliance. This Risk Characterization was conducted in accordance with 310 CMR 40.0900 of the Massachusetts Contingency Plan (MCP), the Massachusetts Department of Environmental Protection's (MassDEP) Guidance for Disposal Site Risk Characterization - In Support of the MCP (MassDEP, 1995), and current risk assessment practice in Massachusetts. The purpose of this Risk Characterization is to evaluate potential risk of harm to health, safety, public welfare and the environment posed by compounds of potential concern (COPC) associated with the Site (RTN 3-23246.)

The Risk Characterization considered soil, groundwater, soil vapor, ambient air and indoor air data collected during the Phase II CSA within the Site boundaries. Using a standard screening process, the following compounds were defined as Constituents of Potential Concern (COPCs). 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1-dichloroethene, tetrachloroethene, trans-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride are COPCs for all soil, groundwater, indoor air, and outdoor air exposures. Chloroform, chloroethane, and carbon tetrachloride were also defined as COPCs for soil, groundwater, and soil vapor exposures only.

Dose-response information was obtained from MassDEP sources, including a document entitled "Revised Proposed Interim Unit Risk Revision for Tetrachloroethylene" (MassDEP, 2008). The proposed interim Unit Risk Factor of 1×10^{-5} ($\mu\text{g}/\text{m}^3$)-1 for tetrachloroethylene (PCE) proposed in this document has been approved for use in this Risk Characterization in a May 13, 2008 letter from Irene M. Dale and John F. Miano Jr. of the Bureau of Waste Site Cleanup to John Badey of UniFirst Corporation, as clarified in an email from Ms. Dale to Ileen Gladstone, of GEI Consultants, Inc. on July 2, 2008.

For purposes of this Risk Characterization, the Site was divided into the following six exposure areas for the purposes of estimating potential risks. (1) Property, (2) 60 Tufts Street, (3) Tufts Street Area, (4) Alston Street Area, (5) Other Streets Area, and (6) Neighborhood Streets.

The Property exposure area includes the 50 Tufts Street property. The 60 Tufts Street exposure area includes the 60 Tufts Street property. The Tufts Street Area includes the following



properties: 9 Tufts Street, 11-13 Tufts, Street, 17 Tufts Street, 19 Tufts Street, 23 Tufts Street, 25 Tufts Street, 27 Tufts Street, and the railroad. Samples collected within Tufts Street adjacent to these defined properties were also included in this exposure area. 50 Tufts Street and 60 Tufts Street were not included in this exposure area. The Alston Street Area includes samples collected within Alston Street and the following properties located on the western-side of Alston Street: 142-146 Cross Street, 2 Alston Street, 6 Alston Street, 10 Alston Street, 12 Alston Street, 16-20 Alston Street, and 30-40 Alston Street. The Other Streets Area includes properties along portions of the following streets located north and west of Tufts Street: Glen Street, Morton Street, Knowlton Street, Franklin Street, Franklin Avenue, Palmer Avenue, Hadley Court, Cobble Hill Road, New Washington Street, and Washington Street. The Capuano Center (located at 150 Glen Street) and samples collected within streets adjacent to these defined properties were also included in this exposure area. Finally, the Neighborhood Streets Area, evaluated to assess the Utility Worker receptor, includes all samples collected within the streets located in the boundaries of the Site. This area overlaps the areas designated as "Tufts Street Area", "Alston Street Area", and "Other Streets Area" in that it includes the roadways that form a portion of those areas.

The Risk Characterization considered both current and future uses of properties within the Site area. Where applicable, receptors included residents, students, teachers, resident trespassers, resident visitors, commercial workers, maintenance workers, landscape workers, utility workers, and construction workers. Where applicable, exposure pathways included incidental ingestion and dermal contact with soil, incidental ingestion and dermal contact with groundwater, inhalation of airborne constituents in ambient air, and inhalation of airborne constituents in indoor air.

The results of the Risk Characterization are as follows. The total noncarcinogenic Hazard Indices (HIs) for all evaluated scenarios are at or below MassDEP's target HI of 1. These results indicated that a condition of "No Significant Risk" exists for non-cancer effects of current and future exposures at each exposure area within the Site. The total Excess Lifetime Cancer Risks (ELCRs) for all evaluated scenarios are at or below MassDEP's target risk level of 1×10^{-5} . The ELCR calculations are based on conservative exposure durations and exposure point concentration assumptions. These results indicate that a condition of "No Significant Risk" exists for carcinogenic effects of current and future exposures at each exposure area within the Site.

The Risk Characterization did not quantitatively evaluate exposures to COPCs in indoor air in buildings that are currently used for residential or educational purposes, because the presence of chlorinated volatile organic compounds (CVOCs) is a Critical Exposure Pathway (CEP) and will result in mitigation. The results of this Risk Characterization are also contingent on the continued existence of the EPEM already installed in the building at the Property, or inclusion of



vapor barriers or other measures as an integral part of the design and construction of any future buildings at the Property, whether commercial or residential.

In accordance with 310 CMR 40.0994, the risk of harm to safety and public welfare was evaluated. No overt situations posing a threat of physical harm or bodily injury exist, nor have persistent odors associated with the release been reported following Immediate Removal Action (IRA) activities. As such, conditions at the Site do not pose a threat of physical harm or bodily injury, and present no dangerous or nuisance conditions. As part of the public welfare evaluation, soil and groundwater Exposure Point Concentrations across the Site were compared to MassDEP's Upper Concentration Levels (UCLs). Groundwater and soil EPCs are below the UCLs in all cases.

Risk to the Environment was evaluated in this risk characterization in accordance with MassDEP guidance: Method 3 Environmental Risk Characterization (MassDEP, 1996) and 310 CMR 40.0000 (MassDEP, 2008a). Based on the terrestrial and aquatic habitat evaluation, no "potentially significant exposures" to identified environmental receptors from COPCs likely exist, and a Stage II Environmental Risk Characterization is not necessary. In addition, conditions at the Site pose No Significant Risk to the Environment.



1.0 INTRODUCTION

This Appendix presents the results of a Method 3 Risk Characterization for potential exposure pathways associated with RTN 3-23246. The Risk Characterization evaluates conditions at the property at 50 Tufts Street in Somerville, Massachusetts (the Property), portions of residential and commercial properties to the east and immediately north, south, and west of the Property, and the Michael E. Capuano Early Childhood Center (the Capuano Center) located at 150 Glen Street in Somerville, Massachusetts. These areas collectively define the "Site".

From approximately 1955 to approximately 2002, the Property, located within the Site, was used for storage and distribution of industrial chemicals, laundry supplies, and dry cleaning supplies. Chemicals stored at and delivered to and from the Property included chlorinated solvents, which contain chlorinated volatile organic compounds (VOCs). These chlorinated VOCs, – particularly tetrachloroethene (PCE), trichloroethene (TCE), and 1,1,1-trichloroethane (TCA) – have been detected in soil, soil vapor, indoor air, and groundwater on the Property.

This Risk Characterization supports the Phase II Comprehensive Site Assessment (Phase II CSA) and is not intended to be a stand-alone document. It summarizes, where applicable, information on property characterization and MCP compliance; however, additional information is contained in the Phase II CSA. In addition, certain Figures referenced in this Appendix are contained in the Phase II CSA to which this Risk Characterization is appended.

This Risk Characterization was conducted in accordance with 310 CMR 40.0900 of the Massachusetts Contingency Plan (MCP), the Massachusetts Department of Environmental Protection's (MassDEP) Guidance for Disposal Site Risk Characterization - In Support of the MCP (MassDEP, 1995), and current risk assessment practice in Massachusetts. The purpose of this Risk Characterization was to evaluate potential risk of harm to health, safety, public welfare and the environment posed by compounds of potential concern (COPC) associated with RTN 3-23246. The boundaries of RTN 3-23246 are depicted in Figure 1-2 of the Phase II CSA and are discussed in section 2.1 of the Phase II CSA Report.



2.0 RISK CHARACTERIZATION APPROACH

A Method 3 approach to risk characterization was selected for the Site. As specified in the MCP (MassDEP, 2008a), the Method 3 Risk Characterization approach is acceptable for any MCP Site.

The Method 3 Risk Characterization of harm to human health included four steps. In the first step, Hazard Identification, Compounds of Potential Concern (COPCs) are selected for quantitative evaluation in the Risk Characterization. The second step, Dose-Response Assessment, describes the relationship between the magnitude of exposure (dose) and the potential occurrence of health effects (response) for each COPC. The third step, Exposure Assessment, identifies potential human receptors based on characteristics of the Site and quantifies the magnitude and frequency of receptors' potential exposure to COPCs. The fourth step, Risk Characterization, combines the information from the previous three steps to derive quantitative estimates of the likelihood for adverse noncarcinogenic health effects or carcinogenic effects.

Potential noncarcinogenic and carcinogenic effects were estimated for each receptor for each potential exposure pathway identified in the Exposure Assessment. The estimated potential risks from each exposure pathway were summed to obtain an estimate of total risk for each receptor. Details on the steps of the human health assessment, as well as the risk characterization of harm to safety, public welfare, and the environment are provided in the remainder of this Appendix.



3.0 HAZARD IDENTIFICATION

The Hazard Identification step includes selection of COPCs for quantitative evaluation in the Risk Characterization. COPCs are selected based on a review of data collected from the Site (described in Section 3.1) using several selection criteria (described in Section 3.2).

3.1 Data Sets

The following sub-sections describe the data collected from various media at the Site.

3.1.1 Soil

As described in the CSA, surface soil samples, subsurface soil samples, and subslab soil samples have been collected from the Property, the neighborhoods to the east and west of the Property, and the Capuano School. The soil data collected from off-Property areas consist of samples collected in 2004 and from 2006 through March 2008. These samples were used to estimate potential risks at off-Property areas of the Site.

Soil samples collected from the Property prior to the commencement of the soil vapor extraction (SVE) system in April 2007 are not considered to be representative of current subsurface conditions on the Property. Therefore, soil data used to assess potential risks at the Property included only post-remediation soil samples.

Tables 11-1a through 11-1f of the Phase II CSA presents the soil data used to estimate potential exposures in this human health Risk Characterization. Table RC-1 provides the frequency of detection for the relevant soil data collected from within the Site boundaries. Soil sample locations are depicted on Figures 4-1 and 4-2 of the Phase II CSA.

3.1.2 Groundwater

Groundwater samples have been collected from 12 monitoring wells at the Property and 27 off-Property monitoring wells during multiple sampling rounds. To adequately characterize groundwater concentrations at the Site and to take into account seasonal variability of data, the four most recent rounds of groundwater samples from each monitoring well were used to estimate potential exposures in this Risk Characterization. All groundwater data used in this assessment were collected by GEI from May 2006 through April 2008.

Elevated detection limits were reported for several compounds in MW-1 during the April 2007 sampling event. Therefore, these detection limits were not included in calculations to determine the temporal average at MW-1, nor were they used to estimate exposure point concentrations (EPCs) for non-detect samples (see Section 5). Tables 11-2a through 11-2f of the Phase II CSA present the soil data used to estimate potential exposures in this human health Risk



Characterization. Because the depth to groundwater in the vicinity of the Property ranges from 5 to 15 feet below ground surface (ft bgs), potential human exposure to groundwater is assumed to occur only during hypothesized future utility work activities and dewatering during construction activities. Table RC-1 provides descriptive statistics (i.e., frequency of detection, minimum, average and maximum concentrations) for the all groundwater data collected from the Site.

3.1.3 Soil Vapor

Soil vapor samples used to estimate potential exposures in this Risk Characterization were collected by GEI from January 2007 through April 2008. Soil vapor samples were collected from 20 locations within the Site boundaries during several rounds of investigation. Potential exposures of construction and utility workers was estimated using soil vapor data collected from monitoring wells equipped with a soil vapor sampling port and valve.

Soil vapor samples collected during soil vapor extraction system testing conducted in July 2007 on the Property (samples SVT-8D, SVT-14S, and SVT-22D) were not used in the Risk Characterization because they are not representative of current conditions because the SSDS and SVE system continue to operate. Sub-slab soil vapor data were not used to estimate potential risks to utility and construction workers because such data are not representative of the soil vapor in areas reasonably anticipated to affect such workers.

Tables 11-3a through 11-3f of the Phase II CSA present the soil vapor data used to estimate potential exposures in this human health Risk Characterization. Refer to the Phase II CSA for a description of soil vapor point installation and sampling techniques.

As summarized in Section 7-4 of the Phase II CSA, GEI evaluated soil vapor intrusion as a potential exposure pathway based on site-wide groundwater, soil, and indoor air sampling results. The evaluation included a program of sub-slab soil vapor testing and indoor air testing at 62 residential and commercial properties within a several-block area near the Property. The criteria for mitigation in residences and in commercial buildings are summarized in Section 7.4.2 and Section 7.4.3 of the Phase II CSA, respectively.

Based on the sub-slab vapor testing and indoor air testing results, GEI has recommended implementing Exposure Pathway Elimination Measures (EPEMs) at 29 buildings as of March 31, 2008, 3 based on sub-slab soil vapor results and 26 based on indoor air results. GEI has been unable to obtain contact information for, or were unable to reach, four property owners and four owners refused testing. Figure 7-1 of the Phase II CSA depicts the residential and commercial properties identified for the soil vapor intrusion pathway evaluation. A summary of the recommended actions based on the testing results are provided in Table 7-1 the Phase II CSA.



As established in IRA Modification Report Modification #1 (RTN 3-26114) prepared by GEI, an EPEM will be installed at all residential properties in which it is determined that chlorinated volatile organic compounds (CVOCs) have the potential to impact indoor air or indoor air testing has documented a CEP (GEI, 2007). Evaluation of potential indoor air impacts within residential properties is not presented in this Risk Characterization because the MCP directs that mitigation of a CEP be undertaken without regard to any assessment of potential risk.

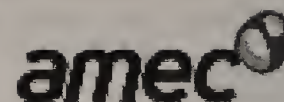
Sub-slab vapor data were collected from the following commercial properties: 30-40 Alston Street, 142 Cross Street, 163 Glen Street, 85 Washington Street, 97 Washington Street, 103 Washington Street, and 121 Washington. Total CVOCs detected within the sub-slab vapor at 103 Washington triggered installation of an EPEM. Sub-slab vapor testing did not trigger installation of an EPEM at the remaining commercial properties although indoor air samples were also collected. Since an EPEM was installed at 103 Washington Street, the indoor air pathway was not considered in the Risk Characterization. GEI was unable to access the commercial properties located at 91 and 113 Washington Street; therefore, insufficient sub-slab vapor data or indoor air testing are currently available to determine potential exposures within these buildings.

3.1.4 Indoor Air

Indoor air data used in this Risk Characterization were collected by GEI in 2007 and 2008 at six locations within the building at the Property (North Office, South Office, North Warehouse, North Central Warehouse, South Central Warehouse, and Garage Area). Indoor air samples collected in the Property building prior to the commencement of the sub-slab depressurization system (SSDS) in April 2007 are not representative of current conditions. Therefore, indoor air samples collected within the Property building subsequent to installation of the SSDS and SVE system (during sampling rounds in October 4 and December 7, 2007) were used in this Risk Characterization to assess potential exposures to indoor air in the Property building. The locations of indoor air samples collected within the Property building are depicted on Figure 6-3 of the Phase CSA II.

Indoor air samples were collected by GEI from the following off-Property commercial buildings in 2007 and/or 2008: 30-40 Alston Street, 142 Cross Street, 163 Glen Street, 85 Washington Street, 97 Washington Street, and 121 Washington Street. Refer to the Phase II CSA for a description of indoor air sampling locations and techniques. The locations of these commercial properties are depicted on Figure 1-2 of the Phase II CSA.

The commercial building at 30-40 Alston Street is occupied by a costume shop (Costume Works located at 32 Alston Street) and a printing shop (Flagraphics, Inc. located at 40 Alston Street). Alston Street is upgradient and south of the Property. On March 8, 2007, two sub-slab soil



vapor samples were collected from beneath the costume shop, and four sub-slab soil vapor samples were collected from beneath the printing shop. PCE concentrations in these samples ranged from below the method reporting limit ($1.4 \mu\text{g}/\text{m}^3$) to $9.5 \mu\text{g}/\text{m}^3$ in sample SS5 collected beneath the printing shop. Because PCE was not detected in soil and groundwater samples collected from Alston Street, and because sub-slab vapor concentrations of PCE were less than the MassDEP-provided subslab vapor intrusion action level, detected concentrations of CVOCs within the indoor air of 30-40 Alston Street were attributed to sources associated with operations of the current businesses. Potential exposure to CVOCs migrating from the subsurface to indoor air in this building is not a complete exposure pathway, and potential risks associated with exposure to indoor air are not evaluated in this Risk Characterization.

As mentioned above, GEI was unable to access the commercial properties located at 91 and 113 Washington Street. Therefore, insufficient data are available to determine whether potential exposure to CVOCs migrating from the subsurface to indoor air in these buildings is a complete exposure pathway. As such, potential exposures to indoor air at these commercial properties were not evaluated in the Risk Characterization.

Potential exposures to indoor air were not evaluated at the commercial property at 103 Washington Street because an EPEM is currently operating in the building. Potential exposures to CVOCs in indoor air were also not assessed at the commercial building located at 142 Cross Street because indoor air samples indicated non-detect levels of total CVOCs.

Indoor air samples collected from 163 Glen Street, 85 Washington Street, 97 Washington Street, and 121 Washington Street were used to estimate potential exposures to CVOCs in indoor air at these properties.

An SSDS system is currently operating at the Capuano Center. A description of the Response Actions undertaken at the Capuano Center is presented in Section 8 of the Phase II CSA. Indoor air samples collected prior to Response Actions are not representative of current conditions. Results of indoor air samples collected from the Capuano Center subsequent to installation and equilibration of the SSDS system indicated no detectable concentrations of CVOCs. Because the indoor air pathway is incomplete, this pathway was not evaluated at the Capuano Center.

Tables 11-4a through 11-4f of the Phase II CSA present the indoor air data used to estimate potential exposures in this human health Risk Characterization. Table RC-2 provides frequency of detection, information for all indoor air data collected within the Site.



3.1.5 Outdoor Air

Outdoor air data used in this Risk Characterization were collected by GEI in 2006 and 2008 from on-Property and from off-Property locations. Outdoor air sample locations are depicted on Figure 7-6 of the Phase II CSA. These samples were used to estimate potential exposures to outdoor air at the Site.

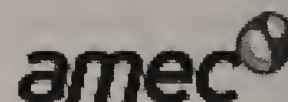
Outdoor air samples collected at the Property (North Parking Lot and South Parking Lot samples) in August 2007 are not representative of current conditions at the Property because a soil stockpile was present during the sampling event. The stockpile was generated during the installation of the SVE system and was removed from the Property subsequent to the outdoor air sampling round. Potential exposures to outdoor air at the Property were estimated using samples collected during other rounds of investigation.

Tables 11-5a through 11-5f of the Phase II CSA present the outdoor air data considered in this human health Risk Characterization. Table RC-3 provides the frequency of detection of all outdoor air data collected within the Site boundaries.

3.2 Exposure Areas

The Site was divided into the following six exposure areas for the purposes of estimating potential risks:

- **Property:** This exposure area includes the 50 Tufts Street property. The results from soil, groundwater, indoor air, and outdoor air samples were used to estimate potential risks for receptors in this area.
- **60 Tufts Street:** This exposure area includes a portion of the 60 Tufts Street property. The results from soil, groundwater, soil vapor, and outdoor air samples were used to estimate potential risks for receptors in this area. Samples collected along Tufts Street were not included in this exposure area.
- **Tufts Street Area:** This exposure area includes the following properties: 9 Tufts Street, 11-13 Tufts Street, 17 Tufts Street, 19 Tufts Street, 23 Tufts Street, 25 Tufts Street, 27 Tufts Street, and the railroad right of way. Samples collected within Tufts Street adjacent to these defined properties were also included in this exposure area. 50 Tufts Street and 60 Tufts Street were not included in this exposure area. The results from soil, groundwater, soil vapor, and outdoor air samples were used to estimate potential risks for receptors in this area.



- **Alston Street Area:** This exposure area includes samples collected within Alston Street and the following properties located on the western-side of Alston Street: 142 Cross Street, 2 Alston Street, 6 Alston Street, 10 Alston Street, 12 Alston Street, 16-20 Alston Street, and 30-40 Alston Street. The results from soil, groundwater, soil vapor, outdoor air, and indoor air samples were used to estimate potential risks for receptors in this area. Samples collected from MW-105 located approximately 50 feet north of Alston Street, along Cross Street, were also included in this dataset.
- **Other Streets Area:** This exposure area includes portions of the following streets located north and west of Tufts Street: Glen Street, Morton Street, Knowlton Street, Franklin Street, Franklin Avenue, Palmer Avenue, Hadley Court, Cobble Hill Road, New Washington Street, and Washington Street. The Capuano Center (located at 150 Glen Street) and samples collected within streets adjacent to these defined properties were also included in this exposure area. The results from soil, groundwater, soil vapor, and outdoor air samples were used to estimate potential risks for receptors in this area. In addition, indoor air samples were used to estimate potential risks for the following commercial properties in this area: 163 Glen Street, 85 Washington Street, 97 Washington Street, and 121 Washington Street.
- **Neighborhood Streets:** For the Utility Worker receptor, this exposure area includes samples collected within all streets located within the Site boundaries. This area overlaps the areas designated as "Tufts Street Area", "Alston Street Area", and "Other Streets Area" in that it includes the roadways that form a portion of those areas. The results from soil, groundwater, and soil vapor samples from the roadways were used to estimate potential risks for utility worker receptors in this area.

The boundaries of these exposure areas are depicted on Figure RC-1. Table RC-4 lists soil, groundwater, soil vapor, and outdoor air samples that were considered in this Risk Characterization within each of the above-defined exposure areas.

3.3 Selection of Compounds of Potential Concern

A multiple-step screening procedure was used to identify COPCs for quantitative evaluation in the Risk Characterization. First, samples collected from the Property were evaluated to identify compounds that potentially may be associated with RTN 3-23246. If a compound was not detected at a concentration above its laboratory method detection limit in subsurface samples (soil, groundwater, and soil vapor) collected from the Property, then it was not selected as a COPC in any medium in any area. Samples evaluated in this step included:



- Soil samples collected from the Property from July 2002 through March 2008 (with the exception of samples collected in August 2007 to characterize soil for disposal purposes);
- Groundwater samples collected from the Property from January 2007 through April 2008; and
- Soil vapor samples collected from the Property between January 2007 through April 2008 (including samples collected during evaluation of the remediation system in July 2007, but excluding samples collected from beneath the slab of the Property building).

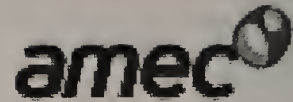
Table RC-1 identifies compounds detected in at least one soil, groundwater, and/or soil vapor sample collected from the Property. Compounds that were not detected in any sample from the Property were eliminated from the COPC screening process. A total of 31 compounds were detected in at least one sample and were retained for evaluation in the second step of the COPC screening process.

In the second step, if a compound was detected at a very low frequency ($\leq 5\%$) in all three media (soil, groundwater, and soil vapor) it was excluded as a COPC. The frequency of detection was based on samples collected from within the Site boundaries as noted above, including samples collected on the Property. A total of 15 compounds were detected at a frequency of less than or equal to 5%, and were eliminated from the COPC screening process. A total of 16 compounds were detected with a frequency greater than 5% and were retained for evaluation in the third step of the COPC screening process.

In the third step, if detected concentrations of a compound were higher in off-Property samples than the maximum concentration detected in samples from the Property, and if the compound was not consistent with historical operations at the Property, then it was eliminated from the COPC screening process. The following compounds were eliminated in this step of the COPC screening process: benzene, 1,2-dichloroethane, methyl tert-butyl ether, naphthalene, and toluene.

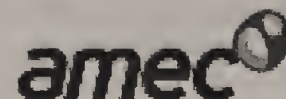
Using this screening process, the following eleven compounds were selected as COPCs: vinyl chloride, trichloroethene, 1,1,1-trichloroethane, trans-1,2-dichloroethene, tetrachloroethene, 1,1-dichloroethene, cis-1,2-dichloroethene, 1,1-dichloroethane, chloroform, chloroethane, and carbon tetrachloride. The COPC screening process is summarized in Table RC-1 of this report.

Analytical results for certain COPCs detected in indoor and outdoor air samples were questionable, based on a review of groundwater sample results, and a determination of whether the compound is a breakdown product of the chlorinated solvents detected on the Property. AMEC's review indicated that detected concentrations of the following compounds in indoor air and outdoor air are not associated with RTN 3-23246: chloroform, chloroethane, and carbon



tetrachloride. As a result, these compounds were not considered COPCs in indoor air or outdoor air. The rationale for this determination is described below for each relevant compound:

- Chloroform – Chloroform has been detected at low concentrations (0.88J to 13.3 µg/L) in groundwater samples from only five wells (SH-4, SH-MW1, SH-MW3, MW-1 and MW-3). These concentrations are well below MassDEP's Method 1 GW-2 Standard (50 µg/L), which is protective of residential exposure to indoor air. It was not detected in wells adjacent to any residence evaluated in the Risk Characterization, and therefore, would not contribute significantly to potential indoor air exposures. Chloroform is commonly present in environmental samples as a result of laboratory sample processing, and is not a degradation product of the chlorinated solvents detected at the Property.
- Chloroethane – Chloroethane has only been detected in one off-Property monitoring well located approximately 400 feet downgradient from the Property boundaries (MW-116) at levels slightly above the laboratory detection limit (2.3 and 2.4 µg/L); and therefore, does not pose a risk of impacting indoor air quality.
- Carbon Tetrachloride – Carbon tetrachloride was not detected in soil or groundwater samples collected outside the boundaries of the Property. In addition, carbon tetrachloride was above the laboratory detection limit in only one indoor air sample collected within the off-Property portion of the Site. Further, carbon tetrachloride was detected in all outdoor air samples at similar values because of its ubiquitous nature in ambient air.



4.0 DOSE-RESPONSE ASSESSMENT

The purpose of the Dose-Response Assessment is to identify the relationship between the magnitude of COPCs to which receptors may be exposed (dose) and the likelihood of an adverse health effect (response). Both noncarcinogenic (i.e., threshold) and carcinogenic (i.e., non-threshold) health effects were considered in the dose-response assessment. The information provided in the Dose-Response Assessment was combined with the results of the Exposure Assessment (Section 5) to provide an estimate of potential health risk.

Dose-response information used in this Risk Characterization was obtained from MassDEP publications (MassDEP, 2008b), including a document entitled "Revised Proposed Interim Unit Risk Revision for Tetrachloroethylene" (MassDEP, 2008c). The proposed interim Unit Risk Factor of $1 \times 10^{-5} (\mu\text{g}/\text{m}^3)^{-1}$ for tetrachloroethylene (PCE) proposed in this document was approved for use in this Risk Characterization in a May 13, 2008 letter from Ms. Irene M. Dale and Mr. John F. Miano Jr. of the MassDEP Bureau of Waste Site Cleanup to John Badey of UniFirst Corporation as clarified in an email from Ms. Dale to Ileen Gladstone, of GEI Consultants, Inc. on July 2, 2008.

Toxicity values for chloroethane were not available from MassDEP Publications. Therefore, toxicity values for chloroethane were obtained from EPA's Integrated Risk Information System. The toxicity data used in this Risk Characterization are shown in Table RC-5.

4.1 Noncarcinogenic Dose-Response

Compounds with known or potential noncarcinogenic effects were assumed to have a dose below which no adverse effect occurs, or conversely, above which an effect may be seen. In laboratory experiments, this dose is known as the "No Observed Adverse Effect Level" (NOAEL). The lowest dose at which an adverse effect is seen is called the "Lowest Observed Adverse Effect Level" (LOAEL). By applying uncertainty factors to the NOAEL or the LOAEL, Reference Doses (RfDs) and Reference Concentrations (RfCs) are developed for chronic and, in some cases, subchronic, exposures to compounds with potential noncarcinogenic effects. Many of the non-carcinogenic dose-response values provided by MassDEP (2008b), were developed by the U.S. EPA and are reported in U.S. EPA (2008), while other values provided in MassDEP (2008b) were developed by MassDEP.

Uncertainty factors account for uncertainties associated with the dose-response data, such as the appropriateness of using an animal study to derive a human dose-response value, and the potential for especially sensitive subpopulations to exist, which may not be adequately represented by the laboratory test animals. For compounds with potential noncarcinogenic effects, the RfD or RfC provides reasonable certainty that, if the specified exposure dose is



below the threshold, then no noncarcinogenic health effects are expected to occur. RfDs are expressed in terms of milligrams of compound per kilogram of body weight per day (mg/kg-day) and are used to evaluate estimated oral and dermal exposures. RfCs are expressed in terms of milligrams of compound per cubic meter of air (mg/m³) and are used to evaluate estimated inhalation exposures in a specific exposure context (continuous exposure for a chronic period of time). Table RC-5 summarizes the toxicity values for the COPCs evaluated here by the inhalation and oral / dermal exposure routes.

4.2 Carcinogenic Dose-Response

The U.S. EPA assumes for regulatory risk assessment that no threshold dose exists (U.S. EPA, 1990, 1997). In other words, U.S. EPA assumes that a finite level of risk may be associated with any dose above zero. In March 2005, U.S. EPA issued new cancer guidelines (U.S. EPA, 2005), the purpose of which is to recommend principles and procedures to guide U.S. EPA scientists in assessing the cancer risks from chemicals or other agents in the environment when deriving toxicity values. U. S. EPA uses a two-part system for characterizing the extent to which the available data support the hypothesis that an agent causes cancer in humans.

U.S. EPA's first step in evaluating a potential carcinogen is to assign a weight-of-evidence (WOE) classification. Under U.S. EPA's previous cancer guidelines released in 1986, the WOE was described by categories "Group A" through "Group E", with Group A category reserved for known human carcinogens, while Group E category was the other end of the spectrum, representing compounds/agents with evidence of non-carcinogenicity. In the U.S. EPA's more recent approach for carcinogen risk assessment (U.S. EPA, 2005), all scientific information is considered in determining whether and under what conditions an agent may cause cancer in humans. Furthermore, the WOE provides a narrative approach to characterize carcinogenicity rather than distinct categories by summarizing the evidence about the likelihood of the compound being a human carcinogen. Five standard WOE descriptors are currently used as part of the narrative, including:

1. Carcinogenic to Humans
2. Likely to be Carcinogenic to Humans
3. Suggestive Evidence of Carcinogenic Potential
4. Inadequate Information to Assess Carcinogenic Potential
5. Not Likely to be Carcinogenic to Humans

As part of the updated guidance on evaluating potentially carcinogenic compounds, the U.S. EPA emphasizes the value of understanding the biological changes that the agent of interest



can cause (e.g., mode of action) and how these changes might lead to the development of cancer. This information, as well as the agent's human carcinogenic potential, is to be described in a narrative prepared by U.S. EPA's scientists, summarizing the full range of available evidence and describing any conditions associated with conclusions about an agent's hazard potential, including which populations or life stages may be particularly susceptible. Because the data for many of the potentially carcinogenic compounds have not been re-evaluated since the initial derivation of the cancer slope factors under the 1986 cancer guidelines, the cancer toxicity information presented in Integrated Risk Information System (IRIS - U.S. EPA's database of recommended cancer slope factors and reference doses for use in risk assessments) represents cancer toxicity information derived under the 1986 guidelines, with more recent cancer evaluations conducted for a limited number of compounds under the more recent 2005 guidance (U.S. EPA, 2008).

The second step in the carcinogenicity evaluation process is the calculation of a quantitative estimate of carcinogenic potency. The U.S. EPA has developed computer models that extrapolate the observed responses at high doses used in animal studies to predict responses in humans at the low doses encountered during environmental exposures. The models developed by the U.S. EPA assume no threshold and usually consider animal (and sometimes human) data to estimate carcinogenic potency. Further, the models assume that carcinogenic dose-response is linear at low doses. U.S. EPA refers to this numerical estimate of the dose response factor (or the slope of the line plotted from dose vs. response) as the cancer slope factor (CSF) for oral exposures. For inhalation exposures, the numerical estimate is expressed as either a unit risk (UR) factor or CSF. A CSF is expressed in terms of the inverse of milligrams of agent per kilogram body weight per day $[(\text{mg/kg-day})^{-1}]$ and represents the upper-bound excess lifetime cancer risk estimate that results from a daily lifetime exposure to an agent at a dose of 1 mg/kg-day. The UR is expressed in terms of the inverse of micrograms per cubic meter $[(\text{ug/m}^3)^{-1}]$ and represents the upper-bound excess lifetime cancer risk estimated to result from continuous daily lifetime exposure to an agent at a concentration of 1 ug/m^3 in air. Table RC-5 summarizes carcinogenic toxicity values for COPCs used in this Risk Characterization.



5 EXPOSURE ASSESSMENT

5.1 Receptors and Exposure Pathways

Consistent with the requirements of the MCP, 310 CMR 40.0923, the exposure assessment considered both current and reasonably foreseeable future activities and uses at the Site. Receptors at the Site are summarized in the following subsections.

5.1.1 The Property

The Property is approximately 51,111 square feet (sf) and is located at 50 Tufts Street in Somerville Massachusetts. The Property is currently developed with an approximately 20,594-sf, one-story, masonry block building. The majority of the building is warehouse space, and small areas used as office space are within the north and south portion of the Property building. Approximately 95 percent of the Property is surrounded by a chain-linked fence. Figure 1-2 of the attached Phase II CSA shows the location of the Property.

Current use receptors at the Property consist of indoor and outdoor commercial workers, local residents who may trespass at the property, maintenance workers/landscapers who occasionally visit the property to perform routine activities. The potentially complete exposure pathways for these current receptors include incidental ingestion and dermal contact with accessible surficial soil (0 to 3 feet below ground surface (ft bgs)), and inhalation of soil derived particulates and volatiles in ambient air. Groundwater at the Property is not currently used (and is not expected to be used in the future) as a potable water source. Groundwater underlying the Property meets none of the definitions of a Current or Potential Drinking Water Source Area and as such is not categorized as GW-1. The inhalation of COPCs within indoor air of the building was also evaluated as a current exposure pathway for the indoor commercial workers.

Future use receptors at the Property consist of future construction workers during potential future excavation/development activities, utility workers during emergency repair or future development activities, outdoor employees of future commercial buildings, visitors to potential future commercial buildings, indoor employees of future commercial buildings, residents of future residential developments and landscapers. Complete exposure pathways for these future receptors are summarized below:

- The potentially complete exposure pathways for the Property construction worker receptor include incidental ingestion and dermal contact with soil located between 0 and 15 ft bgs, inhalation of particulates within ambient air, and the inhalation of volatiles from soil, soil vapor, and/or groundwater. It was assumed that dewatering will occur prior to future construction activities and that direct contact with groundwater during construction will be minimal. Therefore, a construction worker's incidental ingestion and dermal



contact with groundwater were not quantitatively assessed in the Risk Characterization.

- The potentially complete exposure pathways for the Property utility worker receptor include incidental ingestion and dermal contact with soil located between 0 and 6 ft bgs, inhalation of particulates within ambient air, and the inhalation of volatiles from soil, soil vapor, and/or groundwater and incidental ingestion and dermal contact with groundwater within future trench excavations.
- The potentially complete exposure pathways at the Property for the future outdoor employees of the commercial building, future visitors, future residents, and future landscapers include incidental ingestion and dermal contact with accessible 0 to 3 ft bgs soils and inhalation of particulates and volatiles within ambient air. It is assumed that vapor barriers or other measures will be integral to the design and construction of any future buildings at the Property, whether commercial or residential. Therefore, indoor air is not a complete exposure pathway for future residential or commercial receptors. Future outdoor employees of the commercial building, future visitors, future residents, and future landscapers could also be exposed to potentially accessible soils located 0-15 ft bgs that may have been relocated to the surface during property development activities.

5.1.2 Off-Property areas

The area surrounding the Property is characterized by residential and commercial development. Public properties include a primary school, a playground, community gardens, and public streets. Current use receptors in the off-Property portion of the Site consist of local residents, indoor and outdoor employees of commercial buildings, visitors to residences and commercial buildings, landscapers, railroad workers who may perform maintenance on nearby tracks, and students and teachers at the Capuano Center. The potentially complete exposure pathways for these current receptors include incidental ingestion and dermal contact with accessible surficial soil (0 to 3 ft bgs), inhalation of soil derived particulates and volatiles in ambient air.

As summarized in Section 3.1.3 and 3.1.4, GEI conducted a soil vapor intrusion evaluation of potentially affected commercial and residential properties within a several-block area near the Property. Remedial actions have been conducted at the Capuano Center to mitigate the indoor air exposure pathway and an EPEM will be installed in all residential buildings in which a CEP is identified. Since CEP's will be mitigated, this Risk Characterization does not evaluate indoor air exposures within residential properties where a CEP has been identified. Alternately, low levels of detectable CVOCs within commercial properties do not necessarily require the installation of an EPEM and indoor air is therefore considered a complete exposure pathway for current commercial buildings located within the off-Property areas of the Site.



Groundwater is not currently used (and is not expected to be used in the future) as a potable water source. Groundwater meets none of the definitions of a Current or Potential Drinking Water Source Area and as such is not categorized as GW-1.

Future use receptors of the off-Property areas of the Site consist of future construction workers during potential future excavation/development activities, utility workers during emergency in-street repairs or installations, indoor and outdoor employees of commercial buildings, visitors to commercial buildings, residents, and students and teachers of the Capuano Center. Complete exposure pathways for these receptors are summarized below:

- The potentially complete exposure pathways for the construction worker receptor include incidental ingestion and dermal contact with soil located between 0 and 15 ft bgs, inhalation of particulates within ambient air, and the inhalation of volatiles from soil, soil vapor, and/or groundwater. It was assumed that dewatering will occur prior to future construction activities and that direct contact with groundwater will be minimal. Therefore, a construction worker's incidental ingestion and dermal contact with groundwater were not quantitatively assessed in the Risk Characterization.
- The potentially complete exposure pathways for the utility worker receptor include incidental ingestion and dermal contact with soil located between 0 and 6 ft bgs, inhalation of particulates within ambient air, and the inhalation of volatiles from soil, soil vapor, and/or groundwater and incidental ingestion and dermal contact with groundwater within future trench excavations.
- The potentially complete future exposure pathways for outdoor employees in commercial buildings, visitors to commercial buildings, residents, and students and teachers of the Capuano Center include incidental ingestion and dermal contact with soil (0 to 15 ft bgs) that may have been relocated to the surface during property development activities, inhalation of soil derived particulates and volatiles in ambient air. The indoor air exposure pathway within commercial properties that are developed as residential in the future is also considered in this Risk Characterization.

5.2 Soil and Groundwater Categorization

For this Risk Characterization, soil categories were identified for current and future Site conditions. Based on potential exposures for the most sensitive current receptors (the off-Property resident and the child trespasser at the Property), exposed soil from 0-3 ft bgs is categorized as S-1 because the soil is currently accessible and the child's potential exposure is considered to be of high intensity. Exposed soil from 3-15 ft bgs is categorized as S-2. Soil



deeper than 15 ft bgs, soil located beneath existing buildings, and soils located within the right-of-way is categorized as S-3 per 310 CMR 40.0933 (MassDEP, 2008a).

The Risk Characterization assumes that the Property and all off-Property parcels may be developed for residential use in the future. Residents who may be present at the Site in the future under a residential use assumption will likely have high frequency with high intensity contact with soil. Based on potential exposures for the highest exposed receptor (resident), soil currently located from 0-15 ft bgs is categorized as S-1.

Groundwater underlying the Site meets none of the definitions of a Current or Potential Drinking Water Source Area and as such, is not categorized as GW-1. Groundwater at the Site containing COPCs that is within 30 feet of occupied buildings and less than 15 feet below grade meets the criteria for categorization as GW-2 as defined by 310 CMR 40.0933 (MassDEP, 2008a). Groundwater is categorized as GW-3 because, as provided in 310 CMR 40.0932, all groundwater of the Commonwealth is assumed to discharge to surface water and thus is categorized as GW-3.

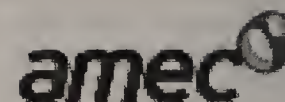
5.3 Exposure Points

Exposure points (also called exposure areas) are defined as locations of potential contact between a receptor and portions/media of a property. The exposure point concentration (EPC) is defined as the chemical concentration in a given medium which a potential receptor may encounter at an exposure point. As summarized in Section 3 of this Appendix, Site data were divided into six distinct exposure points: 1) Property, 2) 60 Tufts Street, 3) Tufts Street Area, 4) Alston Street Area, 5) Other Streets Area, and 6) Within Neighborhood Streets Area. The methods used to estimate EPCs within each exposure area are described in Section 5.6. The boundaries of each of these areas are depicted on Figure RC-1. Table RC-4 summarizes the samples considered in this Risk Characterization that were collected within each exposure area.

5.3.1 Soil

It was assumed that the current receptors would be exposed to COPCs present in accessible surface soil (unpaved and located 0 to 3 ft bgs) within each of the six exposure areas delineated on Figure RC-1. Future residential and commercial receptors would be exposed to COPCs detected in soil located 0 to 15 ft bgs within each of the six exposure areas delineated on Figure RC-1.

The exposure point for future utility workers on the Property was defined as soil located between 0-6 ft bgs within the Property boundaries. The exposure point for future utility workers in the "Within Neighborhood Streets" exposure point was defined as soil located 0-6 ft bgs within all streets located within the Site boundaries.



The soil exposure point for the construction worker and other future receptors identified in Section 5.1 was defined as soil from 0-15 ft bgs located within each of the six exposure areas delineated on Figure RC-1.

5.3.2 Groundwater and Soil Vapor

Direct exposures to groundwater will only occur during utility activities at the Property and within the neighborhood streets. Monitoring wells that were quantitatively considered in the Risk Characterization are listed in Table RC-4.

Soil vapor data were used to estimate ambient air concentrations within future construction and utility excavations/trenches. Soil vapor sampling locations that were quantitatively considered in the Risk Characterization are listed in Table RC-4.

5.3.3 Indoor air

The Property building is comprised of a warehouse and garage, and a small portion is office space. To evaluate current exposures, the Property building was divided into two exposure points: 1) The warehouse and garage and 2) The South and North Office area.

Indoor air was considered an exposure point in the following commercial buildings: 163 Glen Street, 85 Washington Street, 97 Washington Street, and 121 Washington Street. Indoor air data collected at these properties are used to quantify indoor air exposures to current commercial workers and potential future residents.

As discussed in Section 3.1.4 of this Report, detected concentrations of CVOCs within 30-40 Alston Street are attributable to sources associated with the current businesses and were not evaluated in this Risk Characterization.

GEI was unable to access the commercial properties located at 91 and 113 Washington Street; therefore, insufficient data are currently available to determine potential exposures within these buildings. The indoor air pathway was not considered at 103 Washington Street due to the presence of an EPEM. In addition, Non-detects results of total CVOCs within the commercial building located at 142 Cross Street indicate that no additional assessment is necessary at this location.

The presence of chlorinated VOCs above the laboratory reporting limit in the indoor air at the Capuano Center represents a CEP; therefore, GEI designed and oversaw the installation of an SSDS to mitigate migration of COPCs from beneath the floor slab into the indoor air. Therefore, indoor air was not considered an exposure point for receptors at the Capuano Center in this



Risk Characterization. Response actions within the Capuano Center are summarized in Section 8 of the Phase II CSA.

5.3.4 “Hotspot” Evaluation

The MCP typically requires evaluation of exposures, as well as Upper Concentrations Limits (UCL) comparisons in “hotspots”. The MCP (310 CMR 40.0006) defines a “hotspot” as an area where concentrations are more than 100-fold higher than the surrounding areas, except where the potential for greater exposure exists. At these latter sub-areas, concentrations more than 10-fold higher than surrounding concentrations might be “hotspots.” At this Site, no specific point or sub-area represents a location with higher potential for exposure than elsewhere. Inspection of the data does not indicate substantial variability. For the soil data “hotspot” reviews, the highest detected concentrations were compared to surrounding concentrations, while for the groundwater, and soil vapor data “hotspot” reviews, the highest temporally averaged concentrations were compared to temporally averaged surrounding concentrations. In no case was a maximum concentration surrounded by concentrations more than 100-fold lower than the maximum. Therefore, no “hotspots” are present.

5.4 A Quantitative Evaluation of Potential Exposure Pathways

Exposure pathways are the mechanisms by which potential receptors may be exposed to COPCs at the Site. Individuals hypothetically exposed at high intensities and frequencies at each exposure point were quantitatively evaluated. Figure RC-2 summarizes the risk scenarios evaluated quantitatively in this Risk Characterization.

5.5 Qualitative Evaluation of Potential Exposures

Quantitative evaluations based on hypothetical receptors with the greatest potential for exposure in each exposure point area result in conservative estimates for receptors conducting less intrusive roles on the Site. Specifically, trespassers, visitors, and railroad workers at the Site would have lower frequencies of exposure than a full-time commercial worker or a resident. Using the same rationale, the visitors, trespassers, and railroad workers in each exposure area were evaluated qualitatively via comparison to quantified exposures for the commercial and residential receptors. Similarly, current commercial workers within the Alston Street exposure area were evaluated qualitatively via comparison to quantified exposures for the current residential receptors. Landscapers and maintenance workers on the off-property portions of the Site were also evaluated qualitatively via comparison to quantified construction worker exposures. If “No Significant Risk” was demonstrated for the more highly exposed receptor, it was indicative of “No Significant Risk” to less exposed receptors.



5.6 Estimation of Exposure Point Concentrations

The EPC is defined as the chemical concentration in a given medium that a potential receptor may encounter at an exposure area. The following sections define EPCs for each exposure medium in each of the defined exposure areas of the Site (Figure RC-1). A summary of soil, groundwater, soil vapor, indoor air, and outdoor air EPCs used in this Risk Characterization can be found in Table RC-6. Sample locations considered in this Risk Characterization are summarized in Table RC-4; data used to determine the EPCs within each exposure point are summarized in the Tables 11-1(a-f) through 11-5 (a-f) of the Phase II CSA;. This Risk Characterization performed a Worst Case assessment for exposures to off-Property soil, soil vapor, and groundwater. This was accomplished by designating the maximum soil, soil vapor, and groundwater sample as the EPC for each COPC for each of the five off-Property exposure areas: (1) 60 Tufts Street Area, (2) Tufts Street Area, (3) Alston Street Area, (4) Other Streets Area, and (5) Within Neighborhood Streets Area (for Utility Worker receptors).

5.6.1 Soil

Soil EPCs were developed for each exposure area defined in Section 3.2 from the datasets described in Section 3.1. The arithmetic mean of measured concentrations within the Property exposure area was used as the EPC of each COPC for the identified receptors at the Property. The arithmetic means of the measurement data are representative of the true means for the exposure scenarios evaluated because a sufficient number of samples were collected to provide adequate horizontal and vertical coverage of the Site, and the data do not indicate a high level of variability. Additionally, no "hotspots" were identified. As is standard practice for human health risk assessments, the arithmetic mean of the measured concentrations was calculated assuming that non-detected compounds were present at one-half the laboratory reporting limit.

The soil EPCs for the remaining five off-Property exposure areas are defined as the maximum detected concentration of each COPC within each of the defined areas (Figure RC-1). If a COPC was not detected in a given exposure area, then one-half the lowest laboratory reporting limit was used as the EPC for that COPC.

5.6.2 Groundwater

Groundwater EPCs were developed for each exposure area where potential exposure may exist. To adequately represent seasonal influences on groundwater concentrations, the arithmetic mean of COPC concentrations detected was calculated for each monitoring well in each exposure area using the four most-recent rounds of groundwater samples (2006 to 2008), and the maximum calculated average was used as the EPC for the future construction and utility scenarios. The arithmetic mean of the measured concentrations was calculated assuming that non-detected compounds were present at one-half the laboratory reporting limit. If a COPC



was not detected in a given exposure area, then one-half the lowest laboratory reporting limit was used as the EPC for that COPC.

Elevated laboratory detection limits were reported for non-detect analytes in monitoring well MW-1 (located on the Property) during the April 2007 sampling event. The elevated detection limits were the result of sample dilution required at the laboratory to meet instrument requirements. These elevated detection limits were not used to calculate the arithmetic mean of the last four groundwater sampling rounds for monitoring well MW-1. It is important to note that concentrations actually detected in MW-1 during the April 2007 sampling event were included in the arithmetic mean

5.6.3 Soil Vapor

Soil vapor EPCs were developed for each exposure area of the Site where potential exposure may exist. The arithmetic mean was calculated within each monitoring point of the last four rounds of soil vapor samples (2007 to 2008) and the maximum calculated average was the EPC of each COPC for the future construction and utility scenarios. The arithmetic mean of the measured concentrations was calculated assuming that non-detected compounds were present at one-half the laboratory reporting limit. If a COPC was not detected in a given exposure area, then one-half the lowest laboratory reporting limit was used as the EPC for that COPC.

5.6.4 Indoor Air

EPCs were developed for both of the current indoor air exposure points identified within the Property building: 1) the warehouse and garage and 2) the South and North Office area. The arithmetic mean of measured concentrations collected within each exposure point was used to represent the EPC of each COPC at the Property. The arithmetic mean of the measured concentrations was calculated assuming that non-detected compounds were present at one-half the laboratory reporting limit.

The indoor air EPCs for the remaining off-Property indoor air exposure points (commercial buildings: 163 Glen Street, 85 Washington Street, 97 Washington Street, and 121 Washington Street) are the arithmetic mean of the measured concentrations in indoor air. If a COPC was not detected in a given exposure area, then one-half the lowest laboratory reporting limit was used as the EPC for that COPC. Since indoor air samples were collected from both the basement and the first floor of the commercial properties located at 97 Washington Street, a time weighted average was calculated. The time weighted average used to calculate the EPCs for the commercial scenario at 97 Washington Street assumed that a worker spends 1 hour in the basement and the remaining 7 hours of the work day on the first floor. The time weighted average used to calculate the EPCs for the future residential scenario at 97 Washington Street



conservatively assumes that a receptor spends 4 hours in the basement and 20 hours on the first floor.

If a COPC was not detected in one of these commercial buildings, then one-half the lowest laboratory reporting limit was used as the EPC for that COPC.

5.6.5 Ambient Air

Outdoor Air EPCs were developed for each of the six areas defined in section 3.1.6: 1) Property, 2) 60 Tufts Street, 3) Tufts Street Area, 4) Alston Street Area, 5) Other Streets Area, and 6) Within Neighborhood Streets. For each area, the arithmetic mean of measured concentrations in outdoor air was used to represent the EPC of each COPC for the identified receptors. The arithmetic mean of the measured concentrations was calculated assuming that non-detected compounds were present at one-half the laboratory reporting limit. If a COPC was not detected in outdoor air in a given exposure area, then one-half the lowest laboratory reporting limit was used as the EPC for that COPC.

To evaluate potential exposures to constituents that may volatilize from soil, soil vapor, and/or groundwater into the ambient air of an excavation or utility trench, EPCs for ambient air were estimated for use in the construction and utility scenarios. The concentrations for ambient air within an excavation or trench were predicted from each of the above-defined EPCs for soil, groundwater, and soil vapor. The average of the three predicted ambient air values was then retained as the EPC for ambient air for the construction worker and utility worker scenarios.

The vapor transport models used to estimate ambient air EPCs in the excavation/trench are based on a series of simple models that predict the concentrations of volatile compounds in ambient air as a result of migration from soil and groundwater sources using volatilization factors. Essentially the models assume partitioning from soil and groundwater into the vapor compartment of the vadose zone, followed by molecular diffusion to the soil surface. The flux of vapor from the soil surface is then assumed to mix into a "box" of air above the source. Compounds in the box are cleared by ambient air movement, so that the equilibrium concentration in the box can be calculated when volatile flux is combined with wind-based removal. For the purposes of the present risk assessment, in which the "box" is a below-ground excavation, the models were modified slightly in the following ways:

1. The dimensions of the box were set at the assumed dimensions of an excavation or trench.
2. The source area for volatile flux was set at the dimensions of the surface of the excavation floor and sidewalls in the case of a soil source.
3. The source area for volatile flux from groundwater was set immediately below the excavation/trench floor.



4. The ambient windspeed was reduced to account for possible interference with the removal process caused by the subsurface nature of the excavation. No data are available for the relative reduction in ventilation that might be expected, so the value was set to one-half for the surface windspeed for the construction worker excavation scenario and one-tenth for the utility worker scenario.

A more detailed discussion of the models is provided in Attachment B to this report, and the predicted ambient air concentrations modeled from soil, groundwater, and soil vapor are shown in the models/risk calculations contained in Attachment A. Refer to Table RC-6 for the average of the three predicted ambient air values that was retained as the EPC for ambient air for the construction worker and utility worker scenarios. Physical properties used to model excavation and trench air EPCs for each COPC are summarized in Table RC-9.

5.7 Quantification of Potential Exposures

This section describes the equations and assumptions used to evaluate potential exposures to compounds detected at the property. These equations are consistent with equations presented by MassDEP (1995) and risk assessment guidance issued by the U.S. EPA (1989).

The Average Daily Dose (ADD) was calculated to estimate a receptor's potential daily intake from exposure to compounds with potential noncarcinogenic effects. According to MassDEP (1995) and U.S. EPA (1989), the exposure dose should be calculated by averaging over the period of time for which the receptor is assumed to be exposed. Subsequently, the ADD for each compound via each route of exposure was compared to the noncarcinogenic toxicity value (that is, the RfD or RfC) for that compound in order to estimate the potential noncarcinogenic hazard index due to exposure to that compound via that route of exposure.

For compounds with potential carcinogenic effects, the lifetime average daily dose (LADD) was calculated to estimate potential exposures over the course of a lifetime (70 years). Subsequently, the LADD for each compound via each route of exposure was multiplied by the CSF or UR for that compound to estimate the potential carcinogenic risk due to exposure to that compound via that route of exposure.

The equations used to estimate ADDs and LADDs are presented below. The human exposure parameters used in each potential exposure pathway are presented in Table RC-7. The spreadsheets used to calculate ADD and LADD from these equations and parameter values are contained in Attachment A to this Appendix.

5.7.1 Soil

Exposure to soil was assumed to occur via incidental ingestion and dermal contact. ADDs and LADDs for soil ingestion were calculated as follows:

$$ADD_{ing} \text{ or } LADD_{ing} = \frac{C_{soil} \times IR_{soil} \times FI \times RAF_{os} \times CF \times EF \times EP}{AT \times BW}$$

where:

ADD _{ing}	=	Average Daily Dose Due to Ingestion (mg/kg-day)
LADD _{ing}	=	Lifetime Average Daily Dose Due to Ingestion (mg/kg/day)
C _{soil}	=	Compound Concentration in Soil (mg/kg)
IR _{soil}	=	Soil Ingestion Rate (mg/day)
FI	=	Fraction of Soil Ingested From the Site (unitless)
RAF _{os}	=	Relative Absorption Factor (Oral-Soil) (unitless)
CF	=	Conversion Factor (10 ⁻⁶ kg/mg)
EF	=	Exposure Frequency (days/year)
EP	=	Exposure Period (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (EP x 365 days/yr, ADD; 70yr x 365 days/yr, LADD)

ADDs and LADDs for dermal absorption were calculated as follows:

$$ADD_{der} \text{ or } LADD_{der} = \frac{C_{soil} \times SA \times AF \times RAF_{ds} \times CF \times EF \times EP}{AT \times BW}$$

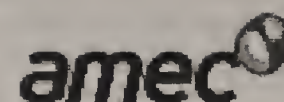
where:

ADD _{der}	=	Average Daily Dose Due to Dermal Contact (mg/kg-day)
LADD _{der}	=	Lifetime Average Daily Dose Due to Dermal Contact (mg/kg/day)
C _{soil}	=	Compound Concentration in Soil (mg/kg)
SA	=	Skin Surface Area Exposed (cm ² /day)
AF	=	Soil to Skin Adherence Factor (mg/cm ²)
RAF _{ds}	=	Relative Absorption Factor (Dermal-Soil) (unitless)
CF	=	Conversion Factor (10 ⁻⁶ kg/mg)
EF	=	Exposure Frequency (days/year)
EP	=	Exposure Period (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (EP x 365 days/yr, ADD; 70yr x 365 days/yr, LADD)

The calculation of a LADD as opposed to an ADD is simply a matter of averaging time (AT).

5.7.2 Groundwater

Incidental groundwater exposure was also assumed to occur during construction work. The exposure equation is as follows:



$$\text{ADD or LADD} = \frac{\text{CW} \times [(\text{IR} \times \text{FI} \times \text{RAFo}) + (\text{SA} \times \text{PC} \times \text{RAFd})] \times \text{ED} \times \text{EF} \times \text{EP} \times \text{CF1} \times \text{CF2}}{\text{BW} \times \text{AP}}$$

where:

ADD	=	Average Daily Dose Due to Ingestion and Dermal Contact (mg/kg-day)
LADD	=	Lifetime Average Daily Dose Due to Ingestion and Dermal Contact (mg/kg-day)
CW	=	Compound Concentration in Water (mg/L)
IR	=	Incidental Water Ingestion Rate (ml/hr)
FI	=	Fraction Ingested from Site (unitless)
RAFo	=	Relative Absorption Factor (Oral-Water) (unitless)
SA	=	Skin Surface Area Exposed to groundwater (cm ² /hr)
PC	=	Skin Permeability (cm/hr) (these are compound-specific)
RAFd	=	Relative Absorption Factor (Dermal-Water) (unitless)
ED	=	Exposure Duration (hr/day)
EF	=	Exposure Frequency (days/year)
EP	=	Exposure Period (years)
CF1	=	Conversion Factor (ml/cm ³)
CF2	=	Conversion Factor (L/ml)
BW	=	Body Weight (kg)
AP	=	Averaging Period (EP * 365 d/yr for noncancer; 70 yr * 365 d/yr for cancer)

5.7.3 Inhalation of Particulates

Inhalation of particulates (fugitive dust) was also evaluated. Exposure via inhalation of soil-derived fugitive dust is a function of the concentration at the source (e.g., soil), frequency and duration of contact, and a factor describing the concentration of compound in respirable particles in air.

MassDEP (2002a) considers that potential exposure via inhalation of dust occurs via two uptake pathways: uptake by the vaportointestinal (GI) tract following coughing up and subsequent swallowing of particulates trapped by the mucosa of the upper respiratory track and uptake by the respiratory system following inhalation into the lungs. To calculate the exposure associated with these two uptake pathways, MassDEP (2002a) assumes the following for the construction worker scenario (which AMEC conservatively also used for other receptors):

1. 100% of respirable particulate mass (PM) is equal to or less than 30 microns in diameter ($\leq \text{PM}_{30}$)
2. 40% of total respiratory particulate mass is equal to or less than 10 microns in diameter ($\leq \text{PM}_{10}$)
3. 100% of inhaled particulates greater than 10 microns but less than or equal to 30 microns are swallowed. 50% of inhaled particulates equal to or less than 10 microns are swallowed
4. 50% of inhaled particulates equal to or less than 10 microns enters the lungs.



Based on these assumptions, the effective exposure concentration of respirable particulates for the GI system is 2 times the concentration of PM₁₀, while that for the lungs is 0.5 times the concentration of PM₁₀. Using these effective exposure concentrations, OHM average daily doses for the GI and respiratory systems can be estimated using the following equations.

Average Daily Dose for the GI System (ADD_{inhalation-GI}):

$$ADD_{inhalation - GI} = \frac{[C_{part}] \times 2 \times [PM_{10}] \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{BW \times AT}$$

where:

ADD_{inhalation-GI} = Average daily dose due to coughing up and subsequent ingestion of inhaled particulates; expressed in mg/kg-day
 [C_{part}] = Concentration of OHM in airborne particulates
 [PM₁₀] = Concentration in air of particulates less than or equal to 10 microns in diameter
 IR_{air} = Inhalation rate for the receptor of concern during the period of exposure
 RAF_i = Relative Absorption Factor (inhalation)
 ET = Duration of each exposure event (hr/day)
 EF = Exposure frequency (days/year)
 EP = Duration of the exposure period (years)
 C = Appropriate unit conversion factor
 BW = Body weight of the receptor of concern during the averaging period
 AT = Averaging time

Average Daily Dose for the Respiratory System (ADD_{inhalation})

$$ADD_{inhalation} = \frac{[C_{part}] \times 0.5 \times [PM_{10}] \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{BW \times AT}$$

where:

ADD_{inhalation} = Average daily dose due to inhaled particulates entering the lungs (mg/kg-day)
 [C_{part}] = Concentration of OHM in airborne particulates (mg/kg)
 [PM₁₀] = Concentration in air of particulates less than 10 microns in diameter (ug/m³)
 IR_{air} = Inhalation rate (m³/hr)
 RAF_i = Relative Absorption Factor
 ET = Duration of each exposure event (hr/day)
 EF = Exposure frequency (days/yr)
 EP = Duration of the exposure period (years)
 C = Appropriate unit conversion factor (10⁻⁹ kg/ug)
 BW = Body weight (kg)
 AT = Averaging time (d)

Dose-response values for inhalation exposure (i.e., unit risk and reference concentration) are expressed on a mass of compound per volume of air basis, using the assumption that a person weighs 70 kg and has a daily inhalation rate (Inh_{day}) of 20 m³. Therefore, prior to the



characterization of risk, $ADD_{\text{inhalation}}$ (mg/kg-day) for the compound must be converted to an average daily exposure ($ADE_{\text{inhalation}}$) (mg/m³) in order to make it compatible with the corresponding dose-response values. This can be accomplished using the following equation:

$$ADE_{\text{inhalation}} = C_{\text{air}} \times AF$$

where:

$$ADD_{\text{inhalation}} = \frac{ADD_{\text{inhalation}} \times BW_{\text{assumed}}}{Inh_{\text{assumed}}}$$

- $ADE_{\text{inhalation}}$ = Average daily oil/hazardous material concentration to which a receptor is exposed (mg/m³)
 $ADD_{\text{inhalation}}$ = Average daily dose due to inhaled particulates entering the lungs (mg/kg-d)
 BW_{assumed} = Body weight assumed in the development of RfCs and URFs (70 kg)
 Inh_{assumed} = Daily inhalation rate assumed in the development of RfCs and URFs (20 m³/d)

For the evaluation of the construction worker, landscaper, and outdoor worker, the concentration of PM₁₀ in air was assumed to be 60 ug/m³ (MassDEP, 2002a). For other receptors, a PM₁₀ concentration of 32 ug/m³ was used (MassDEP, 1995)

5.7.4 Inhalation of Indoor and Ambient Air

Inhalation exposures to ambient or indoor air are evaluated using RfCs and URs. These values represent a level of risk or hazard associated with hypothetically continuous exposure (i.e., 24 hours per day for a lifetime). Therefore, these toxicity factors must be used with an Average Daily Exposure (ADE) rather than an ADD as calculated for oral or dermal exposures. The ADE is simply the estimated exposure point concentration adjusted for non-continuous exposures:

$$ADE = C_{\text{air}} \times AF$$

where:

- ADE = Average Daily Exposure (µg/m³-day)
 C_{air} = Concentration of COPC in air
 AF = Adjustment Factor (unitless)

and where:

$$AF = \frac{ED \times EF \times EP}{24 \frac{\text{hr}}{\text{d}} \times 365 \frac{\text{d}}{\text{y}} \times AP}$$

where:

ED	=	exposure duration (hr/day)
EF	=	exposure frequency (days/yr)
EP	=	exposure period (years)
AP	=	averaging period (years)

Exposure durations and frequencies MassDEP (2008b) default values for construction workers and indoor workers.

5.8 Relative Absorption Factors (RAFs)

The premise of calculating risk or hazard using toxicity data from laboratory experiments is that potential human exposure dose is similar to the administered dose or applied dose in the laboratory experiment. The animal-derived cancer slope factors (CSFs) and reference doses (RfDs) used in quantitative risk assessment were based on applied doses in most cases. However, the efficiency of COPC absorption via a particular route and from a particular matrix (e.g., soil, water) at the Site may differ from the absorption efficiency for the exposure route and matrix used in the experimental study that serves as the basis for the CSF or RfD. RAFs are used to adjust the exposure dose based on these two absorption efficiencies. As recommended by MassDEP (1995) and U.S. EPA (1989), RAFs for COPCs were derived and used in the calculation of human exposure doses.

RAFs used in this Risk Characterization are shown in Table RC-8. The RAFs were obtained from MassDEP (2008b). For COPCs that were not listed in MassDEP (2008b), AMEC has derived RAFs using standard approaches as used by MassDEP (2008b).

5.9 Dermal Permeability Constants

Dermal permeability constants are used in estimating potential dermal exposure to compounds in water. The dermal permeability constant values used in this Risk Characterization were obtained from MassDEP (2008b) and are shown in Table RC-9.



6 RISK CHARACTERIZATION

Risk Characterization includes estimates of the potential human health risks from exposure to noncarcinogens, both in the long term (chronic) and short term (acute). It also includes an assessment of the potential excess cancer risk from exposure to known and possible carcinogens.

Risk characterization is the step in the risk assessment process that combines the results of the exposure assessment and the dose-response assessment for each COPC in order to estimate the potential for noncarcinogenic and carcinogenic human health effects from exposure to that compound. This section summarizes the results of the Risk Characterization for each receptor evaluated in this risk assessment. Estimated total noncarcinogenic and carcinogenic risks for each receptor in each exposure area are presented in Tables RC-10 through RC-35. Table RC-36 summarizes all risk estimates for the evaluated receptors in each exposure area. The risk calculations, which provide results for each receptor, exposure pathway and COPC, are contained in Attachment A.

6.1 Noncarcinogenic Risk Characterization

The potential for exposures to COPCs identified at each exposure area to result in adverse noncarcinogenic health effects was estimated for each receptor by comparing the Average Daily Dose (ADD) for each compound with the Reference Dose for that compound or by comparing the Average Daily Exposure (ADE) to the Reference Concentration. The resulting ratio is known as the Hazard Quotient (HQ) for that compound. The HQ was calculated using the following formula:

$$HQ = \frac{ADD}{RfD}$$

where:

HQ = Hazard Quotient (unitless);
ADD = Average Daily Dose (mg/kg-day); and
RfD = Reference Dose (mg/kg-day) or RfC.

When a Hazard Quotient for a given compound does not exceed 1, the Reference Dose or Reference Concentration has not been exceeded, and no adverse noncarcinogenic health effects are expected to occur. The HQs for each compound were summed to yield the Hazard Index (HI) for that pathway. A total Hazard Index for a chemical was then calculated for each receptor by summing the pathway-specific HIs.

As shown in Tables RC-10 through RC-35 and summarized in Table RC-36, the total HIs for the evaluated scenarios are at or below MassDEP's target HI of 1. These results indicated that a



condition of “No Significant Risk” exists for non-cancer effects of current and future exposures at each exposure area.

6.2 Carcinogenic Risk Characterization

The purpose of carcinogenic risk characterization is to provide a conservative estimate of the likelihood, over and above the background cancer rate, that a receptor will develop cancer in his or her lifetime as a result of exposures to COPCs in various environmental media, assuming but not endorsing the premises established by regulatory authorities (e.g., use of animal studies to estimate carcinogenic potency based on a carcinogenic dose-response relationship that is linear at low doses). This likelihood is a function of the dose of a compound and the Cancer Slope Factor (CSF) for that compound. The relationship between the Excess Lifetime Cancer Risk (ELCR) and the estimated Lifetime Average Daily Dose (LADD) of a compound may be expressed as:

$$\text{ELCR} = 1 - e^{-\text{CSF} \times \text{LADD}}$$

where:

ELCR = Excess Lifetime Cancer Risk (unitless);
CSF = Cancer Slope Factor (1/(mg/kg-day)); and
LADD = Lifetime Average Daily Dose (mg/kg-day).

When the product of the CSF and the LADD is much greater than 1, the ELCR approaches 1 (*i.e.*, 100% probability). When the product is less than 0.01 (1×10^{-2}), the equation can be closely approximated by:

$$\text{ELCR} = \text{CSF} \times \text{LADD}$$

The product of the equation is unitless, and provides a conservative estimate of the potential carcinogenic risk associated with a receptor's exposure to that compound via that pathway. ELCRs are calculated for each potentially carcinogenic compound. For each receptor, the ELCRs for each pathway by which the receptor is assumed to be exposed is calculated by summing the potential risks derived for each compound. A Total Excess Lifetime Cancer Risk is then calculated by summing the pathway-specific ELCRs.

Table RC-36 presents the total ELCRs calculated for the current and future receptors. Risk estimates for individual pathways are summarized in Tables RC-10 through RC-35. As shown in the Tables, the total ELCRs for the evaluated scenarios are at or below MassDEP's target risk of 1×10^{-5} . The ELCR calculations are based on conservative exposure durations and exposure point concentration assumptions. These results indicate that a condition of “No Significant Risk” exists for carcinogenic effects of exposure at each exposure area.



6.3 Applicable or Suitably Analogous Public Health Standards

The MCP at 310 CMR 40.0993 (3) requires an evaluation of Applicable and Suitably Analogous Standards (ASAS) in addition to quantitative risk assessment. The general list of ASAS provided in the MCP is the Massachusetts Drinking Water Quality Standards, the Massachusetts Air Quality Standards, and the Massachusetts Surface Water Quality Standards. Since groundwater at the Site is not categorized as GW-1, the Massachusetts Drinking Water Quality Standards do not apply.

The Massachusetts Air Quality Standards relate to ambient concentrations of the so-called "criteria pollutants" (sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide and lead). Based on the nature of the release, no criteria pollutants are expected to be present at the Site or have been measured in air at the Site.

6.4 Risk to Safety and Public Welfare

In accordance with 310 CMR 40.0994, the risk of harm to safety and public welfare was evaluated. No overt situations posing a threat of physical harm or bodily injury exist, nor have persistent odors associated with the release been reported following IRA activities. As such, conditions at the Site do not pose a threat of physical harm or bodily injury, and present no dangerous or nuisance conditions.

As part of the public welfare evaluation, soil and groundwater EPCs across the Site were compared to UCLs. As indicated in Table RC-37, groundwater and soil EPCs are below the UCLs.

6.5 Risk to the Environment

Risk to the Environment was evaluated in this risk characterization in accordance with MassDEP guidance: Method 3 Environmental Risk Characterization (MassDEP, 1996) and 310 CMR 40.0000 (MassDEP, 2008a). This recent MassDEP guidance provides for two stages of environmental risk characterization:

- Stage I, which is used to identify those situations which require further evaluation; and
- Stage II, which is a detailed evaluation of those environmental exposure pathways identified in Stage I.

As part of Stage I, the available Site information is reviewed to identify the presence of environmental receptors and to determine whether the identified receptors are currently exposed, or could potentially be exposed, to site-related COPCs. According to MassDEP guidance, a "complete exposure pathway means that the contamination is actually reaching



plants or animals, or is likely to do so in the future" (MassDEP, 1996). Exposure pathways that are not complete and are not likely to be complete, are not required to be evaluated further.

For terrestrial habitats, an evaluation of habitat quality was undertaken as the first step of the Stage I screening, in accordance with MASSDEP guidance (1996). To evaluate terrestrial habitat quality, available information (including historical records, data collected within the Site, and field observations) was reviewed.

Based on a review of the MassDEP Priority Resource Map (PRM), there are no Natural Heritage and Endangered Species Program Estimated Habitats for Rare Wetland Wildlife within 500 feet of the Site. According to the Massachusetts Natural Heritage Atlas, there are no priority habitats or rare species, estimated habitats of rare wildlife, or certified vernal pools within 500 feet of the Site. As indicated in the Phase I Initial Site Investigation and Tier Classification Report dated June 16, 2006 and prepared by GEI, the Capuano Center property, located 350 feet east of the Property, is incorrectly shown on the MassDEP PRM as a Protected Open Space. There are no known Areas of Critical Environmental Concern (ACEC) located within 500 feet of the Site.

The Site is greater than two acres; however, areas within the Property and the off-Property portions of the Site are paved. Historical records, data collected within the Site, and field observations do not identify current or past visible physical evidence that oil and/or hazardous material (OHM) at or from the Site have come to be located in surface soil, surface water, sediment or wetlands. Specifically, no sheens from OHM, non-aqueous phase liquids, oil, tar, or other solid or semi-solid hazardous materials have been observed in surface soil, surface water, sediments, or wetlands.

It is also important to note that concentrations of COPCs detected in currently accessible surface soil samples collected in 2008 by GEI are below the most stringent Method 1 Soil Standards (S-1/GW-2 and S-1/GW-3). Based on the low levels of COPCs in accessible surface soils and the scarcity of open land, the Site does not represent significant habitat or provide for exposures for potential terrestrial receptors. Due to the lack of exposure potential, no terrestrial exposure pathways were identified, and further evaluation of terrestrial habitat is not required (MassDEP, 1995).

For the Stage I screening of aquatic habitats, site information was again reviewed. The closest surface water body is the Mystic River, located approximately 1 mile northeast of the Site. Groundwater samples collected downgradient of the Site indicate concentrations of COPCs below Method 1 GW-3 Groundwater Standards, which are protective of potential surface water impacts. Based on the distance to the nearest surface water receptors and the current levels of



COPCs in groundwater, the potential for the transport of COPCs in the groundwater to surface water and sediment receptors is not likely.

Based on the terrestrial and aquatic habitat evaluation, AMEC concludes that no "potentially significant exposures" to identified environmental receptors from COPCs likely exist, and a Stage II Environmental Risk Characterization is not necessary. In addition, conditions at the Site pose No Significant Risk to the Environment.

7 UNCERTAINTY ANALYSIS

Within any of the four steps of the risk assessment process, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. Every assumption introduces some degree of uncertainty into the risk assessment process. Conservative assumptions are made throughout the risk assessment to ensure that the health of local residents and the environment are protected. Therefore, when all of the assumptions are combined, it is much more likely that actual risks, if any, are over-estimated rather than under-estimated.

The assumptions that introduce the greatest amount of uncertainty in this risk assessment are discussed in this section. They are discussed in general terms, because for most of the assumptions there is not enough quantitative information to assign a numerical value that can be factored into the calculation of risk.

7.1 Hazard Identification

During the Hazard Identification step, compounds are selected for inclusion in the quantitative Risk Characterization. Detected compounds in Property soil, groundwater, and soil vapor were considered in the COPC screening evaluation. Therefore, because MCP protocols have been utilized for the several rounds of sampling and analytical methodologies conducted at the property, it is unlikely that exposures to these media are under-estimated by the hazard identification step.

7.2 Dose-Response Assessment

Dose-response values are usually based on limited toxicological data. For this reason, a margin of safety is built into estimates of both carcinogenic and noncarcinogenic risk, and actual risks may be lower than those estimated.

Human dose-response values are often extrapolated, or conservatively estimated, using the results of animal studies. Extrapolation from animals to humans introduces a great deal of uncertainty in the risk assessment because, in most instances, it is not known how differently a human may react to the chemical compared to the animal species used to test the compound. The procedures used to extrapolate from animals to humans involve conservative assumptions and incorporate several uncertainty factors (explicit factors for species extrapolation, and possible sensitive populations in the case of the RfD) that are more likely to over-estimate than under-estimate the no-effect dose in humans.



7.3 Exposure Assessment

During the exposure assessment, average daily doses of COPCs to which receptors are potentially exposed are calculated, which involves assumptions about how often exposure occurs. Such assumptions include location, accessibility, and use of an area. With this in mind, the receptor, or person who may potentially be exposed, and the location of exposure, were both defined for this Risk Characterization. The locations where certain activities were assumed to take place have been purposely selected because chemical concentrations and frequency of exposure are expected to be high (i.e., use of the maximally affected areas). However, actual frequencies of exposure are likely to be much lower than assumed. In these cases, the person's potential exposure would be reduced, and the health risks discussed here would be overestimated.

Community gardens are located on the Capuano Center property within the Site boundaries on the corner of Franklin Street and Palmer Avenue. Soil samples collected from these gardens (Garden 1 and Garden 2 depicted on Figure 4-2 of the Phase II CSA) were included as part of the dataset defined for the "Other Streets" exposure area. No chlorinated VOCs were detected above laboratory reporting limits in either of these two shallow soil samples collected from the community garden. Because garden vegetables are rooted in shallow soil, no detailed assessment of the ingestion of garden vegetables was included in this Risk Characterization. Based on results of Plant Headspace Screening conducted by MassDEP from the community gardens [three leaf samples (yellow leaf, grape leaf and Leanne's flowers) from the off-Site Oliver Street Garden and one leaf sample (mint leaf) from the on-Site Franklin Street Garden], MassDEP also concluded that "there is no indication that exposure to chlorinated VOCs is occurring through the use of the community gardens" (MassDEP, 2008d).

It was assumed that dewatering will occur prior to future construction activities and that direct contact with groundwater during construction will be minimal. Therefore, a construction worker's incidental ingestion and dermal contact with groundwater were not quantified in the Risk Characterization. Contact with groundwater during construction projects will be limited to short-term dewatering activities. Exposures during these activities are likely to be equal to exposures quantified for a utility worker. In this Risk Characterization, exposures for the utility worker receptor were evaluated within the Property and Neighborhood Streets exposure areas. Risk results indicate that utility worker risks are below the MassDEP acceptable levels in these areas.

7.4 Risk Characterization

The risk of adverse human health effects depends on estimated levels of exposure and on dose-response relationships. Once exposure to and risk from each of the selected compounds is calculated, the total risk posed by exposure to soil is determined by combining the health risk



contributed by each compound. Where COPCs do not interact, do not affect the same target organ or do not have the same mechanism of action, summing the risks for multiple COPCs results in an over-estimate of risk posed by the property. However, in order not to understate the risk, it is assumed that the effects of different compounds may be added together. While there does exist the theoretical possibility of greater than additive effects (synergism) among compounds with effects on the same target organ, the phenomenon of less than additive effects (antagonism) is well-recognized in the toxicology literature. Overall the application of the assumption of additivity provides a conservative estimate of health risks.

This Risk Characterization was conducted using conservative assumptions. The arithmetic mean of soil concentrations was conservatively used to estimate risk for the identified receptors on the Property as per the MassDEP Risk Characterization guidance (MassDEP, 1995). The maximum detected analytes in soil and the maximum of temporally averaged soil vapor and groundwater data from all sample locations were conservatively used to estimate worst-case risks within each of the off-Property exposure points. Actual risks for all locations within each off-Property area, except in the vicinity of the specific sample locations where these maximum concentrations were detected, are lower than those reported in the result tables of this report.

For purposes of this Risk Characterization, commercial workers were evaluated as separate indoor and outdoor receptors. As shown in Table RC-7, it is assumed that an outdoor worker spends 120 days per year (8 hours each day) outside, while the indoor commercial worker spends 250 days per year (8 hours per day) inside. For simplicity, total cumulative risks to commercial workers are conservatively presented in Tables RC-10, RC-13, RC-18, RC-22, RC-26, and RC-32 (and summarized in Table RC-36) as the sum of the indoor and outdoor commercial worker exposures. This method overestimates actual cumulative (indoor and outdoor) commercial exposures.



8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A Method 3 Risk Characterization of potential harm to human health, public welfare, and safety for RTN 3-23246 was completed in accordance with the requirements of 310 CMR 40.0000 Subpart I of the Massachusetts Contingency Plan (MCP). Data from Site assessment activities, as well as information from other sources (e.g., MassDEP and U.S. EPA guidance documents) were used to conduct the Risk Characterization.

The Risk Characterization evaluated potential risk to current and future receptors assumed to be exposed to constituents detected in soil, soil vapor, groundwater, indoor air and outdoor air. The results of the Risk Characterization demonstrate that the cancer and non-cancer risks associated with the evaluated exposure scenarios are below the MassDEP acceptable limits.

The Risk Characterization does not evaluate the indoor air exposure pathway in current residential buildings since the detection of Site-related CVOCs in indoor air constitutes a CEP. As proposed by GEI, appropriate EPEMs will be implemented in residences in which Site-related CVOCs are detected in indoor air at levels that exceed laboratory reporting limits. An assessment of potential outdoor residential exposures across the Site indicates that a condition of No Significant Risk exists.

In addition, this Risk Characterization assumes that the indoor air exposure pathway at the Property will be incomplete for commercial or residential developments that might be constructed in the future. Thus, the results of this Risk Characterization are contingent on the operation of the EPEM already installed in the building at the Property, or inclusion of vapor barriers or other measures as an integral part of the design and construction of any future buildings at the Property, whether commercial or residential.

REFERENCES

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Method 3 Risk Characterization (RTN 3-23246)
50 Tufts Street, Somerville, MA
UniFirst Corporation



U.S. EPA. 2008. U.S. Environmental Protection Agency: Integrated Risk Information System (IRIS). Environmental Criteria and Assessment Office, Cincinnati, OH. www.epa.gov/iris.



FIGURE RC-1
EXPOSURE AREAS

FIGURE RC-2

SUMMARY OF QUANTIFIED EXPOSURES

Figure RC-2
Summary of Quantified Exposures
50 Tufts Street, Somerville, MA
UniFirst Corporation

			Current				Future					
			Commercial Worker	Resident	Maintenance Worker / Landscaper	Student at Capuano Center	Utility Worker	Construction Worker	Commercial Worker	Resident	Maintenance Worker / Landscaper	Student at School
Exposure Point	Medium	Pathway										
Property	Soil	Ingestion	x		x		x	x	x	x	x	
		Dermal	x		x		x	x	x	x	x	
		Particulate Inhalation	x		x		x	x	x	x	x	
	Groundwater	Ingestion					x					
		Dermal					x					
	Ambient Air	Inhalation	x		x		x	x	x	x	x	
	Indoor Air	Inhalation	x									
60 Tufts	Soil	Ingestion		x				x	x	x		
		Dermal		x				x	x	x		
		Particulate Inhalation		x				x	x	x		
	Groundwater	Ingestion										
		Dermal										
	Ambient Air	Inhalation		x				x	x	x		
	Indoor Air	Inhalation										
Tufts Street Area	Soil	Ingestion		x				x	x	x		
		Dermal		x				x	x	x		
		Particulate Inhalation		x				x	x	x		
	Groundwater	Ingestion										
		Dermal										
	Ambient Air	Inhalation		x				x	x	x		
	Indoor Air	Inhalation										
Alston Street Area	Soil	Ingestion		x				x	x	x		
		Dermal		x				x	x	x		
		Particulate Inhalation		x				x	x	x		
	Groundwater	Ingestion										
		Dermal										
	Ambient Air	Inhalation		x				x	x	x		
	Indoor Air	Inhalation										
Other Streets Area	Soil	Ingestion	x	x		x		x	x	x		x
		Dermal	x	x		x		x	x	x		x
		Particulate Inhalation	x	x		x		x	x	x		x
	Groundwater	Ingestion										
		Dermal										
	Ambient Air	Inhalation	x	x		x		x	x	x		x
	Indoor Air	Inhalation	x						x	x		
Neighborhood Streets	Soil	Ingestion					x					
		Dermal					x					
		Particulate Inhalation					x					
	Groundwater	Ingestion					x					
		Dermal					x					
	Ambient Air	Inhalation					x					
	Indoor Air	Inhalation										

Notes:

Construction Worker and Utility exposures to Ambient Air occur within an excavation or trench
x = This exposure pathway was quantitatively evaluated in this Risk Characterization



RISK CHARACTERIZATION TABLES

Table RC-1
Summary Statistics of All Soil, Groundwater, and Soil Vapor Data and Summary of Compounds of Potential Concern (COPC) Screening Process
50 Tufts Street, Somerville, MA
UniFirst Corporation

Analyte	Soil			Soil Vapor			Groundwater			COPC Screening
	Number of Detects	Number of Samples	Frequency of Detection	Number of Detects	Number of Samples	Frequency of Detection	Number of Detects	Number of Samples	Frequency of Detection	
Acetone							5	118	4%	a, b
Benzene	2	76	3%				7	118	6%	a
Bromodichloromethane							3	118	3%	b
Carbon disulfide							3	118	3%	a, b
Carbon tetrachloride				14	72	19%	4	139	3%	COPC (c)
Chlorobenzene							6	118	5%	a, b
Chloroethane				12	72	17%	7	139	5%	COPC (c)
Chloroform							22	118	19%	COPC (c)
Chloromethane							6	118	5%	b
Dichloroethane, 1,1-	5	91	5%	33	72	46%	78	139	56%	COPC
Dichloroethane, 1,2-				6	72	8%	5	139	4%	a
Dichloroethene, cis-1,2-	6	91	7%	19	72	26%	58	139	42%	COPC
Dichloroethene, 1,1-	3	91	3%	38	72	53%	77	139	55%	COPC
Ethylbenzene	2	76	3%				4	118	3%	a, b
Isopropyl benzene							1	118	1%	a, b
Methyl tert-butyl ether	2	76	3%				61	118	52%	a
Methylene chloride	3	75	4%				6	118	5%	b
Naphthalene	8	87	9%				5	118	4%	a
Propylbenzene, n-	1	75	1%				1	118	1%	b
Tetrachloroethane, 1,1,1,2-							5	118	4%	b
Tetrachloroethene	49	104	47%	68	72	94%	109	139	78%	COPC
Toluene	6	76	8%				13	118	11%	a
Trans-1,2-Dichloroethene				4	72	6%	13	139	9%	COPC
Trichloroethane, 1,1,1-	12	104	12%	54	72	75%	85	139	61%	COPC
Trichloroethane, 1,1,2-				1	72	1%	5	139	4%	b
Trichloroethene	22	104	21%	59	72	82%	103	139	74%	COPC
Trimethylbenzene, 1,2,4-	2	75	3%				4	118	3%	a, b
Trimethylbenzene, 1,3,5-	1	75	1%				2	118	2%	a, b
Vinyl chloride				14	72	19%	21	139	15%	COPC
Xylene, m,p-	3	76	4%				3	118	3%	a, b
Xylene, o-	3	76	4%				1	118	1%	a, b

Notes:
Blank cell indicates not applicable
a: Eliminated as a COPC because not related to site impacts
b: Eliminated as a COPC because was not analyzed or was detected at a very low (0-5%) frequency in all subsurface media
c: Eliminated as a COPC in indoor air because multiple lines of evidence indicate this analyte will not impact indoor air (discussed further in text)
Highlighted cell indicates the analyte is a COPC
Compounds listed in this table were detected at least once above the laboratory reporting limit in a soil, groundwater, and/or soil gas sample collected at the Property
Soil Frequency of Detection Statistics in this Table are based on soil data collected from 1/2002 through 3/11/2008, with the exception of disposal samples
Groundwater Frequency of Detection Statistics in this Table are based on groundwater data collected from 1/2007 through 4/2008.
Soil Gas Frequency of Detection Statistics in this Table are based on soil gas data collected from 1/2007 through 4/2008, with the exception of sub-slab vapor data.

Table RC-2
Summary Statistics of Indoor Air Data
50 Tufts Street, Somerville, MA
UniFirst Corporation

Analyte	Number of Detects	Number of Samples	Frequency of Detection
Acetone	0	1	0%
Butanone,2- (MEK)	0	1	0%
Carbon tetrachloride	219	423	52%
Chloroethane	1	394	0%
Chloroform	11	30	37%
Chloromethane	27	30	90%
Dichloroethane,1,1-	13	394	3%
Dichloroethane,1,2-	23	399	6%
Dichloroethene, cis-1,2-	7	394	2%
Dichloroethene,1,1-	9	394	2%
Methylene chloride	4	30	13%
Tetrachloroethene	200	396	51%
Toluene	0	1	0%
Trans-1,2-Dichloroethene	0	394	0%
Trichloroethane,1,1,1-	75	403	19%
Trichloroethane,1,1,2-	0	394	0%
Trichloroethene	53	395	13%
Trichloroethene	53	395	13%
Vinyl chloride	0	394	0%

Notes:
Summary table includes all indoor air data collected within the Site boundaries

Table RC-3
Summary Statistics of Outdoor Air Data
50 Tufts Street, Somerville, MA
UniFirst Corporation

Analyte	Number of Detects	Number of Samples	Frequency of Detection
chemical_name	Number of Detects	Number of Samples	FOD
Carbon tetrachloride	17	51	33%
Chloroethane	0	49	0%
Chloroform	0	6	0%
Chloromethane	8	8	100%
Dichloroethane,1,1-	0	49	0%
Dichloroethane,1,2-	0	49	0%
Dichloroethene, cis-1,2-	0	49	0%
Dichloroethene,1,1-	0	49	0%
Methylene chloride	8	8	100%
Tetrachloroethene	24	52	46%
Trans-1,2-Dichloroethene	0	49	0%
Trichloroethane,1,1,1-	11	51	22%
Trichloroethane,1,1,2-	0	49	0%
Trichloroethene	7	50	14%
Vinyl chloride	0	49	0%

Notes:
Summary table includes all outdoor air data collected within the Study Area with the exception of influent
and effluent data collected from systems operating on 50 Tufts and 150 Glen Street

Table RC-4
Summary of Sample Locations within each Exposure Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Area	Medium	Sample Location
Property	Groundwater	GEO-1
Property	Groundwater	GEO-2
Property	Groundwater	MW104
Property	Groundwater	MW-1
Property	Groundwater	MW-3
Property	Groundwater	SH-MW1
Property	Groundwater	SH-MW2
Property	Groundwater	SH-MW3
Property	Groundwater	SH1
Property	Groundwater	SH3
Property	Groundwater	SH4
Property	Groundwater	MW-203
Property	Soil	50 TUFT-SOIL1
Property	Soil	50 TUFT-SOIL2
Property	Soil	50 TUFT-SOIL3
Property	Soil	50 TUFT-SOIL4
Property	Soil	50 TUFT-SOIL5
Property	Outdoor Air	50Tufts-North Parking Lot
Property	Outdoor Air	50Tufts-North Parking Lot 2
Property	Outdoor Air	50Tufts-South Parking Lot
60 Tufts Street	Groundwater	MW201
60 Tufts Street	Groundwater	MW202
60 Tufts Street	Soil	MW201
60 Tufts Street	Soil	MW202
60 Tufts Street	Soil vapor	MW201
60 Tufts Street	Soil vapor	MW202
60 Tufts Street	Outdoor Air	02 Tufts
60 Tufts Street	Outdoor Air	03 Tufts
Tufts Street Area	Groundwater	GEO-4
Tufts Street Area	Groundwater	GEO-5
Tufts Street Area	Groundwater	GEO-6
Tufts Street Area	Groundwater	MW109
Tufts Street Area	Soil	GEO-4
Tufts Street Area	Soil	27 Tufts
Tufts Street Area	Soil	MW109
Tufts Street Area	Soil vapor	MW109
Tufts Street Area	Outdoor Air	50Tufts-North Parking Lot
Tufts Street Area	Outdoor Air	50Tufts-North Parking Lot 2
Tufts Street Area	Outdoor Air	50Tufts-South Parking Lot
Tufts Street Area	Outdoor Air	O1 Tufts
Tufts Street Area	Outdoor Air	O2 Tufts
Tufts Street Area	Outdoor Air	O3 Tufts
Alston Street Area	Groundwater	MW114
Alston Street Area	Groundwater	MW115
Alston Street Area	Groundwater	MW105
Alston Street Area	Soil	10 Alston
Alston Street Area	Soil	MW115
Alston Street Area	Soil	MW114
Alston Street Area	Soil	MW105
Alston Street Area	Soil vapor	MW114
Alston Street Area	Soil vapor	MW115
Alston Street Area	Outdoor Air	04 Tufts

Notes:
 Table summarizes sample locations considered in the Risk Characterization
 See text for a summary of dataset selection decisions
 Boundaries of Exposure Areas are depicted in Figure RC-1

Table RC-4
Summary of Sample Locations within each Exposure Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Area	Medium	Sample Location
Other Streets Area	Groundwater	GEO-3
Other Streets Area	Groundwater	MW116
Other Streets Area	Groundwater	MW102
Other Streets Area	Groundwater	MW103
Other Streets Area	Groundwater	MW110
Other Streets Area	Groundwater	MW111
Other Streets Area	Groundwater	MW112A
Other Streets Area	Groundwater	MW118D
Other Streets Area	Groundwater	MW118S
Other Streets Area	Groundwater	MW118T
Other Streets Area	Groundwater	MW120D
Other Streets Area	Groundwater	MW120S
Other Streets Area	Groundwater	MW121D
Other Streets Area	Groundwater	MW121S
Other Streets Area	Groundwater	MW122
Other Streets Area	Groundwater	MW101
Other Streets Area	Groundwater	MW106
Other Streets Area	Soil	150 Glen Garden1
Other Streets Area	Soil	150 Glen Garden 2
Other Streets Area	Soil	163 Glen
Other Streets Area	Soil	19 Knowlton
Other Streets Area	Soil	29 Knowlton
Other Streets Area	Soil	35-37 Knowlt
Other Streets Area	Soil	74 Franklin
Other Streets Area	Soil	82 Franklin
Other Streets Area	Soil	MW106
Other Streets Area	Soil	MW110
Other Streets Area	Soil	MW111
Other Streets Area	Soil	MW112
Other Streets Area	Soil	MW112A
Other Streets Area	Soil	MW116
Other Streets Area	Soil	MW118D
Other Streets Area	Soil	MW120D
Other Streets Area	Soil	SB121A
Other Streets Area	Soil	BY 13 MORT
Other Streets Area	Soil	BY 4 MORT
Other Streets Area	Soil	MW101
Other Streets Area	Soil	MW102
Other Streets Area	Soil	MW103
Other Streets Area	Soil	MW121D
Other Streets Area	Soil	MW122
Other Streets Area	Soil	95R-FRONT
Other Streets Area	Soil	95R-BACK
Other Streets Area	Soil Subslab	95FRANK-NORTH FILL
Other Streets Area	Soil Subslab	95FRANK-NORTH SILT
Other Streets Area	Soil Subslab	95FRANK-SOUTH FILL
Other Streets Area	Soil Subslab	95FRANK-SOUTH SILT
Other Streets Area	Soil Subslab	95RFRANK-EASTFILL
Other Streets Area	Soil Subslab	95RFRANK-EASTSILT
Other Streets Area	Soil Subslab	95RFRANK-WESTFILL
Other Streets Area	Soil Subslab	95RFRANK-WESTSILT
Other Streets Area	Soil Subslab	95RSUBSOIL
Other Streets Area	Soil vapor	MW116
Other Streets Area	Soil vapor	MW106
Other Streets Area	Soil vapor	MW110
Other Streets Area	Soil vapor	MW111
Other Streets Area	Soil vapor	MW112
Other Streets Area	Soil vapor	MW112A
Other Streets Area	Soil vapor	MW118S
Other Streets Area	Soil vapor	MW120S
Other Streets Area	Soil vapor	MW121S
Other Streets Area	Soil vapor	MW122
Other Streets Area	Outdoor Air	150 Glen Roof
Other Streets Area	Outdoor Air	O1 150Glen
Other Streets Area	Outdoor Air	O2 150Glen
Other Streets Area	Outdoor Air	O5 Tufts
Other Streets Area	Outdoor Air	O6 Tufts

Notes:

Table summarizes sample locations considered in the Risk Characterization

See text for a summary of dataset selection decisions

Boundaries of Exposure Areas are depicted in Figure RC-1

Table RC-4
Summary of Sample Locations within each Exposure Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Area	Medium	Sample Location
Within Neighborhood Streets	Groundwater	MW114
Within Neighborhood Streets	Groundwater	MW115
Within Neighborhood Streets	Groundwater	MW102
Within Neighborhood Streets	Groundwater	MW103
Within Neighborhood Streets	Groundwater	MW105
Within Neighborhood Streets	Groundwater	MW110
Within Neighborhood Streets	Groundwater	MW111
Within Neighborhood Streets	Groundwater	MW112A
Within Neighborhood Streets	Groundwater	MW121D
Within Neighborhood Streets	Groundwater	MW121S
Within Neighborhood Streets	Groundwater	MW122
Within Neighborhood Streets	Groundwater	GEO-3
Within Neighborhood Streets	Groundwater	GEO-4
Within Neighborhood Streets	Groundwater	GEO-5
Within Neighborhood Streets	Groundwater	GEO-6
Within Neighborhood Streets	Soil	MW115
Within Neighborhood Streets	Soil	MW106
Within Neighborhood Streets	Soil	MW109
Within Neighborhood Streets	Soil	MW110
Within Neighborhood Streets	Soil	MW111
Within Neighborhood Streets	Soil	MW112
Within Neighborhood Streets	Soil	MW112A
Within Neighborhood Streets	Soil	MW114
Within Neighborhood Streets	Soil	SB121A
Within Neighborhood Streets	Soil	MW102
Within Neighborhood Streets	Soil	MW103
Within Neighborhood Streets	Soil	MW105
Within Neighborhood Streets	Soil	MW121D
Within Neighborhood Streets	Soil	MW122
Within Neighborhood Streets	Soil	GEO-4
Within Neighborhood Streets	Soil vapor	MW-106
Within Neighborhood Streets	Soil vapor	MW114
Within Neighborhood Streets	Soil vapor	MW115
Within Neighborhood Streets	Soil vapor	MW110
Within Neighborhood Streets	Soil vapor	MW111
Within Neighborhood Streets	Soil vapor	MW112
Within Neighborhood Streets	Soil vapor	MW112A
Within Neighborhood Streets	Soil vapor	MW121S
Within Neighborhood Streets	Soil vapor	MW122

Notes:
 Table summarizes sample locations considered in the Risk Characterization
 See text for a summary of dataset selection decisions
 Boundaries of Exposure Areas are depicted in Figure RC-1

Table RC-5
Toxicity Information
50 Tufts Street, Somerville, MA
UniFirst Corporation

Compound	Reference Dose Oral Chronic Value (mg/kg-day)	Reference Dose Oral Subchronic Value (mg/kg-day)	Reference Concentration Inhalation Chronic Value (mg/m ³)	Reference Concentration Inhalation Subchronic Value (mg/m ³)	Cancer Slope Factor Oral Value (mg/kg-day) ⁻¹	Unit Risk Inhalation Value (ug/m ³) ⁻¹	Cancer Slope Factor Inhalation Value (mg/kg-day) ⁻¹
Carbon tetrachloride	0.0007	0.007	0.43	0.43	0.13	0.000015	0.0525
Chloroethane	0.4 ¹	0.4 ¹	10 ²	10 ²	NA	NA	NA
Chloroform	0.01	0.01	0.66	0.66	NA	0.000023	0.0805
Dichloroethane, 1,1-	0.1	1	0.5	5	NA	NA	NA
Dichloroethene, cis-1,2-	0.01	0.1	0.035	0.035	NA	NA	NA
Dichloroethene, 1,1-	0.05	0.05	0.2	0.2	NA	NA	1.2
Tetrachloroethene	0.01	0.1	4.6	4.6	0.051	0.00001	0.035
Trans-1,2-Dichloroethene	0.02	0.2	0.07	0.7	NA	NA	NA
Trichloroethane, 1,1,1-	0.09	0.9	5.2	5.2	NA	NA	NA
Trichloroethene	0.002	0.02	0.18	0.18	0.011	0.0000017	0.00595
Vinyl chloride	0.003	0.003	0.1	0.1	1.4	0.0000088	0.0308

Notes:

¹ Region 9 Preliminary Remediation Goals (<http://www.epa.gov/region09/waste/sfund/prg/index.html>)

² IRIS (<http://cfpub.epa.gov/ncea/iris/index.cfm>), checked on April 8, 2008.

All other values obtained from MassDEP (2008b,c)

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

EPCs: Commercial Worker, Potential Future Resident, Construction Worker, Utility Worker, and Landscaper at the Property										
Compound	Soil		Groundwater		Soil Vapor		Outdoor Air		Indoor Air	
	Average 0-3' mg/kg	Average 0-15' mg/kg	Maximum of temporal averages mg/L	Maximum of temporal averages mg/m3	Maximum of temporal averages mg/m3	Average of 50 Tufts Street Data mg/m3	Temporal Average Office mg/m3	Temporal Average Warehouse and garage mg/m3	Indoor Air Temporal Average mg/m3	Indoor Air Temporal Average mg/m3
Carbon tetrachloride	4.7E-02	4.8E-02	1.4E-01	NA	NA	**	**	**	**	**
Chloroethane	1.2E-01	1.2E-01	2.5E-01	NA	NA	**	**	**	**	**
Chloroform	NA	NA	1.3E-01	NA	NA	**	**	**	**	**
Dichloroethane, 1,1-	NA	NA	1.5E-01	NA	NA	4.1E-04	4.1E-04	4.1E-04	4.1E-04	4.1E-04
Dichloroethene, cis-1,2-	NA	NA	2.2E-01	NA	NA	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04
Dichloroethene, 1,1-	NA	NA	3.1E+00	NA	NA	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04
Tetrachloroethene	3.1E+00	1.1E+01	6.2E+01	NA	NA	5.5E-03	8.2E-03	8.3E-03	8.3E-03	8.3E-03
Trans-1,2-Dichloroethene	4.7E-02	4.8E-02	1.3E-01	NA	NA	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04
Trichloroethane, 1,1,1-	NA	NA	1.4E+02	NA	NA	8.8E-04	5.5E-04	5.5E-04	5.5E-04	5.5E-04
Trichloroethene	6.7E-02	6.4E-02	1.1E+02	NA	NA	6.9E-04	5.5E-04	5.5E-04	5.5E-04	5.5E-04
Vinyl chloride	4.7E-02	4.8E-02	1.3E-01	NA	NA	2.6E-04	2.6E-04	2.6E-04	2.6E-04	2.6E-04

NA = no data were available for this compound in this medium
** = compound is not a COPC for this medium
*** = medium was not evaluated (refer to text)
**** = weighted average incorporates temporal averages

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

EPCs: Residential Properties, Commercial Properties, and Construction workers on Alston Street Worst case						
Compound	Soil		Groundwater		Soil Vapor	
	Maximum 0-3'		Maximum 0-15'		Maximum of temporal	
	mg/kg	mg/kg	mg/L	mg/m3	mg/m3	Sample "Tufts 04"
Carbon tetrachloride	5.5E-02	4.5E-02	5.0E-04	3.2E-03	3.2E-03	**
Chloroethane	1.4E-01	1.1E-01	1.0E-03	1.4E-03	1.4E-03	**
Chloroform	5.5E-02	4.5E-02	5.0E-04	NA	NA	**
Dichloroethane, 1,1-	5.5E-02	4.5E-02	5.0E-04	1.0E-03	1.0E-03	4.1E-04
Dichloroethene, cis-1,2-	5.5E-02	4.5E-02	5.0E-04	9.0E-04	9.0E-04	4.0E-04
Dichloroethene, 1,1-	5.5E-02	4.5E-02	5.0E-04	1.0E-03	1.0E-03	4.0E-04
Tetrachloroethene	5.5E-02	4.5E-02	5.3E-04	2.2E-02	2.2E-02	7.0E-04
Trans-1,2-Dichloroethene	5.5E-02	4.5E-02	5.0E-04	9.0E-04	9.0E-04	4.0E-04
Trichloroethane, 1,1,1-	5.5E-02	4.5E-02	5.0E-04	1.7E-03	1.7E-03	5.5E-04
Trichloroethene	5.5E-02	4.5E-02	2.0E-03	2.9E-03	2.9E-03	5.5E-04
Vinyl chloride	5.5E-02	4.5E-02	5.0E-04	6.6E-04	6.6E-04	2.6E-04

NA = no data were available for this compound in this medium
** = compound is not a COPC for this medium
*** = medium was not evaluated (refer to text)
**** = weighted average incorporates temporal averages

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

EPCs: Residents and Commercial Properties, and Construction Workers on Tufts Street						
	Worst case					
	Soil	Soil	Groundwater	Soil Vapor	Outdoor Air	
	Maximum of temporal averages		Maximum of temporal averages			
	Maximum 0-3'	Maximum 0-15'	Maximum of temporal averages	Maximum of temporal averages		
Compound	mg/kg	mg/kg	mg/L	mg/m3	mg/m3	
Carbon tetrachloride	8.0E-02	2.8E-02	5.0E-04	1.3E-02	**	
Chloroethane	2.0E-01	5.6E-02	1.0E-03	5.5E-03	**	
Chloroform	NA	2.8E-02	5.0E-04	NA	**	
Dichloroethane,1,1-	8.5E-02	2.8E-02	1.3E-02	8.0E-03	4.1E-04	
Dichloroethene, cis-1,2-	8.5E-02	2.8E-02	1.3E-02	8.0E-03	4.0E-04	
Dichloroethene,1,1-	8.5E-02	2.8E-02	1.3E-02	8.0E-03	4.0E-04	
Tetrachloroethene	9.9E-02	3.2E-01	1.2E+01	8.8E+00	3.5E-03	
Trans-1,2-Dichloroethene	8.0E-02	2.8E-02	5.0E-04	8.0E-03	4.0E-04	
Trichloroethane,1,1,1-	8.5E-02	8.0E-02	9.2E-02	3.3E-01	7.4E-04	
Trichloroethene	8.0E-02	2.8E-02	1.0E-01	3.2E-02	6.3E-04	
Vinyl chloride	8.0E-02	2.8E-02	5.0E-04	5.0E-03	2.6E-04	

NA = no data were available for this compound in this medium
** = compound is not a COPC for this medium
*** = medium was not evaluated (refer to text)
**** = weighted average incorporates temporal averages

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

EPCs: Residential Properties, Commercial Properties, and Construction on Other Streets*						
Compound	Worst case					
	Soil	Soil	Groundwater	Soil Vapor	Outdoor Air	
	Maximum 0-3' mg/kg	Maximum 0-15' mg/kg	Maximum of temporal averages mg/L	Maximum of temporal averages mg/m3	mg/m3	
Carbon tetrachloride	4.9E-02	3.7E-02	5.0E-04	8.7E-01	**	
Chloroethane	1.2E-01	9.5E-02	1.5E-02	3.6E-01	**	
Chloroform	4.9E-02	3.7E-02	8.9E-03	NA	**	
Dichloroethane, 1,1-	1.3E-01	4.3E-01	7.7E-02	1.0E+00	4.7E-04	
Dichloroethene, cis-1,2-	4.9E-02	7.7E-01	2.0E-01	1.7E+00	4.6E-04	
Dichloroethene, 1,1-	4.9E-02	4.9E-01	4.3E-02	1.3E+00	4.6E-04	
Tetrachloroethene	9.9E-01	5.9E+01	6.7E+00	3.3E+02	8.2E-04	
Trans-1,2-Dichloroethene	4.9E-02	3.7E-02	7.6E-03	5.5E-01	4.6E-04	
Trichloroethane, 1,1,1-	7.7E-02	7.7E-02	9.1E-02	3.7E+00	6.4E-04	
Trichloroethene	3.6E-01	6.2E+00	1.5E-01	2.8E+00	6.4E-04	
Vinyl chloride	4.9E-02	3.7E-02	5.8E-02	3.5E-01	3.0E-04	

NA = no data were available for this compound in this medium
 ** = compound is not a COPC for this medium
 *** = medium was not evaluated (refer to text)
 **** = weighted average incorporates temporal averages

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

EPCs: Indoor Air Current Commercial Buildings and Potential Future Residents									
Compound	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air
	30-40 Alston Street	142 Cross St.	163 Glen St.	85 Washington St.	Maximum	Weighted average****	Weighted average****	121 Washington St.	Maximum
	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Carbon tetrachloride	***	***	**	**	**	**	**	**	**
Chloroethane	***	***	**	**	**	**	**	**	**
Chloroform	***	***	**	**	**	**	**	**	**
Dichloroethane, 1,1-	***	***	4.1E-04	4.1E-04	4.1E-04	4.1E-04	4.1E-04	4.1E-04	4.1E-04
Dichloroethene, cis-1,2-	***	***	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04
Dichloroethene, 1,1-	***	***	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04
Tetrachloroethene	***	***	1.5E-03	1.4E-03	1.4E-03	1.2E-03	1.6E-03	1.5E-03	1.5E-03
Trans-1,2-Dichloroethene	***	***	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04	4.0E-04
Trichloroethane, 1,1,1-	***	***	9.3E-04	5.5E-04	5.5E-04	5.7E-04	7.1E-04	5.5E-04	5.5E-04
Trichloroethene	***	***	5.5E-04	5.5E-04	5.5E-04	5.5E-04	5.5E-04	5.5E-04	5.5E-04
Vinyl chloride	***	***	2.6E-04	2.6E-04	2.6E-04	2.6E-04	2.6E-04	2.6E-04	2.6E-04

NA = no data were available for this compound in this medium
 ** = compound is not a COPC for this medium
 *** = medium was not evaluated (refer to text)
 **** = weighted average incorporates temporal averages

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

PCs: Residential Properties, Commercial Properties, and Construction workers on 60 Tufts Street						
Compound	Worst case					
	Soil	Groundwater	Soil Vapor	Outdoor Air		
	Maximum 0-15' mg/kg	Maximum of temporal averages mg/L	Maximum of temporal averages mg/m3	Sample "Tufts 04" mg/m3		
Carbon tetrachloride	4.8E-02	5.0E-04	8.6E-03	**		
Chloroethane	1.2E-01	1.0E-03	4.1E-03	**		
Chloroform	NA	5.0E-04	NA	**		
Dichloroethane, 1,1-	4.8E-02	4.9E-04	1.1E-02	4.1E-04		
Dichloroethene, cis-1,2-	4.8E-02	5.0E-04	8.0E-03	4.0E-04		
Dichloroethene, 1,1-	4.8E-02	4.2E-03	1.3E-01	4.0E-04		
Tetrachloroethene	1.8E-01	2.9E-02	6.0E+00	1.4E-03		
Trans-1,2-Dichloroethene	4.8E-02	5.0E-04	5.5E-03	4.0E-04		
Trichloroethane, 1,1,1-	4.8E-02	1.8E-02	1.2E+00	6.2E-04		
Trichloroethene	3.4E-02	6.0E-03	1.2E+00	5.8E-04		
Vinyl chloride	4.8E-02	5.0E-04	3.6E-03	2.6E-04		

NA = no data were available for this compound in this medium
** = compound is not a COPC for this medium
*** = medium was not evaluated (refer to text)
**** = weighted average incorporates temporal averages

Table RC-6
Summary of Exposure Point Concentrations
50 Tufts Street
Somerville, MA

	EPCs: Utility Worker within Neighborhood Streets			
	Worst case			Soil Vapor Maximum of temporal averages
	Soil	Groundwater	Maximum of temporal averages	
Compound	Maximum 0-6' mg/kg	mg/L		mg/m3
Carbon tetrachloride	2.8E-02	5.0E-04		8.7E-01
Chloroethane	5.6E-02	1.0E-03		3.6E-01
Chloroform	2.8E-02	1.3E-02		NA
Dichloroethane, 1,1-	1.3E-01	4.9E-02		8.0E-01
Dichloroethene, cis-1,2-	2.8E-02	6.6E-02		5.5E-01
Dichloroethene, 1,1-	2.8E-02	2.9E-02		1.3E+00
Tetrachloroethene	9.9E-01	1.2E+01		3.3E+02
Trans-1,2-Dichloroethene	2.8E-02	1.3E-02		4.0E-04
Trichloroethane, 1,1,1-	7.7E-02	9.2E-02		3.7E+00
Trichloroethene	3.6E-01	1.4E-01		1.9E+00
Vinyl chloride	2.8E-02	1.3E-02		3.5E-01

NA = no data were available for this compound in this medium
** = compound is not a COPC for this medium
*** = medium was not evaluated (refer to text)
**** = weighted average incorporates temporal averages

Table RC-7
Exposure Assumptions
50 Tufts Street, Somerville, MA
UniFirst Corporation

				Resident Young Child	Resident Older Child	Resident Adult	Resident TWA				Commercial/ Industrial Worker				Construction Worker			
Medium	Route	Parameter	Units				Value	Source	Comment		Value	Source	Comment		Value	Source	Comment	
Soil	Incidental Ingestion & Dermal Contact	Soil Ingestion Rate	mg/d	100	50	50		a			50	a			100	a		
		Soil TWA Ingestion Rate	mg-y/kg-d				64	b										
		Soil Dermal Contact Skin Exposed	cm²/d	2431	4427	5653		a	Median values for face, hands, forearms, lower legs, and feet of females		3473	a	Median value for face, hands, forearms, and feet of females		3473	a	Median value for face, hands, forearms, and feet of females	
		Soil TWA Dermal Contact Skin Exposed	mg-cm²-y/kg-d-cm²				659	b										
		Soil Dermal Contact Adherence Rate	mg/cm²	0.35	0.14	0.13	0.35	a			0.03	a		0.29	a			
		Soil Exposure Frequency	d/y	150	150	150	150	a		120	a		130	a				
		Soil Exposure Period - Cancer	y	7	7	16	30	a		27	a		1	a				
		Soil Exposure Period - Non-Cancer	y	7	7	16	7	a		27	a		1	a				
		Soil Averaging Time - Cancer	d	25550	25550	25550	25550	a		25550	a		25550	a				
Soil Averaging Time - Non-Cancer	d	2555	2555	5840	2555	a		9855	a		182	a						
Groundwater	Ingestion & Dermal Contact	Groundwater Ingestion Rate	L/d	NE	NE	NE	NE				NE				0.01	d		
		Groundwater TWA Ingestion Rate	L-y/kg-d	NE														
		Groundwater Exposure Frequency	d/y	NE	NE	NE	NE				NE				130	d		
		Groundwater Exposure Period - Cancer	y	NE	NE	NE	NE				NE				1	a		
		Groundwater Exposure Period - Non-Cancer	y	NE	NE	NE	NE								1	a		
		Groundwater Averaging Time - Cancer	d	NE	NE	NE	NE				NE				25550	a		
		Groundwater Averaging Time - Non-Cancer	d	NE	NE	NE	NE				NE				182	a		
		Groundwater Dermal Contact Skin Exposed	cm²	NE	NE	NE	NE				NE				817	a	Median value for hands of females	
		Groundwater TWA Dermal Contact Skin Exposed	cm²-y/kg	NE	NE	NE	NE								2	d		
		Groundwater Dermal Contact Exposure Time	hr/d	NE	NE	NE	NE				NE							
Outdoor Air	Inhalation of Volatiles	Outdoor Air Exposure Time - Volatiles	hr/d	8	8	8	8	d			8	d			8	d		
		Outdoor Air Exposure Frequency - Volatiles	d/y	150	150	150	150	e			120	e			130	d		
		Outdoor Air Exposure Period - Cancer - Volatiles	y	7	7	16	30	a			27	a			1	a		
		Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	7	16	7	a			27	a			1	a		
		Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	25550	25550	25550	a			25550	a			25550	a		
		Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	2555	5840	2555	a			9855	a			182	a		
Outdoor Air	Inhalation of Particulates	Outdoor Air Inhalation Rate - Particulates	m³/hr	0.36	0.7	1.2		c	Light exertion		1.2	c	Light exertion		3.6	a	Heavy exertion	
		Outdoor Air TWA Inhalation Rate - Particulates	m³-y/h-kg				0.60	b										
		Outdoor Air PM10 - Particulates	ug/m³	32	32	32	32	f			32	f			60	f		
		Outdoor Air Exposure Time - Particulates	hr/d	8	8	8	8	d			8	d			8	d		
		Outdoor Air Exposure Frequency - Particulates	d/y	150	150	150	150	e			120	a			130	d		
		Outdoor Air Exposure Period - Cancer - Particulates	y	7	7	16	30	a			27	a			1	a		
		Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	7	16	7	a			27	a			1	a		
		Outdoor Air Averaging Time - Cancer - Particulates	d	25550	25550	25550	25550	a			25550	a			25550	a		
		Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	2555	5840	2555	a			9855	a			182	a		
Indoor Air	Inhalation of Volatiles	Indoor Air Exposure Time	h/d	24	24	24	24	d			8	d			NE			
		Indoor Air Exposure Frequency	d/y	365	365	365	365	d			250	d			NE			
		Indoor Air Exposure Period - Cancer	y	7	7	16	30	a			27	a			NE			
		Indoor Air Exposure Period - Non-Cancer	y	7	7	16	7	a			27	a			NE			
		Indoor Air Averaging Time - Cancer	d	25550	25550	25550	25550	a			25550	a			NE			
		Indoor Air Averaging Time - Non-Cancer	d	2555	2555	5840	2555	a			9855	a			NE			
General		Body Weight	kg	17	39.9	58.7	17	a			61.1	a			58	a		

NE - No exposure via this route
a - MADEP (2008). available from <http://www.mass.gov/dep/service/compliance/riskasmt.htm>
b - Time-weighted average calculated using the following formula:
c - MADEP (1995a). Appendices to the Guidance for Disposal Site Risk Characterization - In support of the Massachusetts Contingency Plan. Interim Final Policy. WSC/ORS-95-141. July, 1995.
d - Professional judgement
e - Value for soil exposure
f - MADEP (2007). Technical Update: Calculation of Risks due to Inhalation of Particulates by Construction Workers. Office of Research and Standards. Available from <http://www.mass.gov/dep/service/compliance/riskasmt.htm> Revised January 2007.
g - Value for construction worker

$$CR_{TWA} = \frac{CR_{YC} \times EP_{YC}}{BW_{YC}} + \frac{CR_{OC} \times EP_{OC}}{BW_{OC}} + \frac{CR_A \times EP_A}{BW_A}$$

where :

CR = Contact Rate
EP = Exposure Period
BW = Body Weight
TWA = Time – Weighted Average
YC = Young Child
OC = Older Child
A = Adult

Table RC-8
Relative Absorption Factors
50 Tufts Street, Somerville, MA
UniFirst Corporation

Compound	Relative Absorption Factor Soil Ingestion Non- Cancer Chronic	Relative Absorption Factor Soil Dermal Non- Cancer Chronic	Relative Absorption Factor Soil Ingestion Non- Cancer Subchronic	Relative Absorption Factor Soil Dermal Non- Cancer Subchronic	Relative Absorption Factor Soil Ingestion Cancer	Relative Absorption Factor Soil Dermal Cancer	Relative Absorption Factor Water Ingestion Non- Cancer Subchronic	Relative Absorption Factor Water Ingestion Non- Cancer Chronic	Relative Absorption Factor Water Ingestion Cancer	Relative Absorption Factor Water Dermal Cancer	Relative Absorption Factor Water Dermal Non- Cancer Chronic	Relative Absorption Factor Water Dermal Non- Cancer Subchronic	Relative Absorption Factor Air Inhalation Cancer	Relative Absorption Factor Air Inhalation Non- Cancer Chronic	Relative Absorption Factor Air Inhalation Non- Cancer Subchronic
Carbon tetrachloride	1	0.1	1	0.1	1	0.1	1	1	1	1	1	1	1	1	1
Chloroethane	1	0.1	1	0.1	NC	NC	1	1	NC	NC	1	1	NC	1	1
Chloroform	1	0.1	1	0.1	NA	NA	1	1	NC	NC	1	1	1	1	1
Dichloroethane,1,1-	1.3	0.13	1.3	0.13	NC	NC	1.3	1.3	NC	NC	1	1	NC	1	1
Dichloroethene, cis-1,2-	1	0.1	1	0.1	NC	NC	1	1	NC	NC	1	1	NC	1	1
Dichloroethene,1,1-	1	0.1	1	0.1	NC	NC	1	1	NC	NC	1	1	1	1	1
Tetrachloroethene	1	0.1	1	0.1	1	0.1	1	1	1	1	1	1	1	1	1
Trans-1,2-Dichloroethene	1	0.1	1	0.1	NC	NC	1	1	NC	NC	1	1	NC	1	1
Trichloroethane,1,1,1-	1	0.1	1	0.1	NC	NC	1	1	NC	NC	1	1	NC	1	1
Trichloroethene	1	0.1	1	0.1	1	0.1	1	1	1	1	1	1	1	1	1
Vinyl chloride	1	0.1	1	0.1	1.53	0.16	1	1	1.53	1	1	1	1	1	1

Notes:
NC - Not calculated
Values obtained from MassDEP.

Table RC-9
Chemical/Physical Properties
50 Tufts Street, Somerville, MA
UniFirst Corporation

Compound	S		H		H'		MW		VP		logK _{ow}		K _{oc}		MP		C _{sat}		K _p	
	Solubility (ug/L)	Solubility (ug/L) Source	Henry's Law Constant (atm- m ³ /mole)	Henry's Law Constant (atm- m ³ /mole) Source	Henry's Law Constant (dimensionl ess)	Henry's Law Constant (dimensionl ess) Source	Molecular Weight (g/mole)	Molecular Weight (g/mole) Source	Vapor Pressure (mm Hg)	Vapor Pressure (mm Hg) Source	Log(Octanol- Water Partition Coefficient (cm ³ /g))	Log(Octanol- Water Partition Coefficient (cm ³ /g)) Source	Organic Carbon- Water Partition Coefficient (cm ³ /g)	Organic Carbon- Water Partition Coefficient (cm ³ /g) Source	Melting Point (degrees C)	Melting Point (degrees C) Source	Soil Saturation Concentration (mg/kg)	Soil Saturation Concentrati on (mg/kg) Source	Dermal Permeability Constant (cm/hr)	Dermal Permeability Constant (cm/hr) Source
Carbon tetrachloride	793000	1	0.0276	1	1.12948109	1	154	2	113	7	2.83	4	152	5	-23	3	969.7093213	7	0.016047227	1
Chloroethane	6710000	1	0.0111	1	0.445	7	64.52	7	1010	1	1.43	7	23.74	7	-138.7	7	1500	7	0.006060215	7
Chloroform	7950000	1	0.00367	1	0.15018825	1	119	2	160	7	1.97	4	52.5	5	-63.6	3	3522.129358	7	0.0068	1
Dichloroethane, 1,1-	5040000	1	0.00562	1	0.22998854	1	99	2	234	7	1.79	4	53.4	5	-96.9	3	2335.18922	7	0.006714289	1
Dichloroethene, cis-1,2-	6410000	1	0.00408	1	0.16696677	1	97	2	202	7	1.76	3	35.5	5a	-80	3	2206.111306	7	0.006582638	6
Dichloroethene, 1,1-	2420000	1	0.0261	1	1.06809625	1	97	2	591	7	1.48	4	65	5	-122.5	3	1668.29468	7	0.004301303	1
Tetrachloroethene	206000	1	0.0177	1	0.72434114	1	166	2	19	7	3.4	4	265	5	-22.3	3	375.9933312	7	0.032688877	1
Trans-1,2-Dichloroethene	4520000	1	0.00938	1	0.38385988	1	97	2	331	7	2.09	4	38	5	-49.8	3	1806.435375	7	0.010869261	1
Trichloroethane, 1,1,1-	1290000	1	0.0172	1	0.70387952	1	133	2	100	7	2.49	4	135	5	-30.4	3	1343.394189	7	0.012548736	1
Trichloroethene	1280000	1	0.00985	1	0.4030938	1	131	2	77	7	2.42	4	94.3	5	-84.7	3	948.5365443	7	0.011577106	1
Vinyl chloride	8800000	1	0.0278	1	1.13766574	1	63	2	2580	7	1.62	4	18.6	5a	-153.7	3	3730.885587	7	0.008248975	1

Notes:
1 Syracuse Research Corporation (<http://www.syrres.com/esc/physdemo.htm>)
2 ATSDR, "Toxicological Profile for _____"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.
3 US EPA Soil Screening Guidance: Technical Background Document, EPA/540/R95/128, May 1996
4 OSHA Documentation of TLV -TWA
5 Measured Koc from the SSL Guidance, Table 39
5a Calculated Koc from the SSL Guidance, Table 39
6 <http://chemfinder.cambridgesoft.com>
7 Risk Assessment Information System (RAIS), <http://rais.ornl.gov/>

Table RC-9
Chemical/Physical Properties
50 Tufts Street, Somerville, MA
UniFirst Corporation

Compound	D _a		D _w		t _H		BP		t _{crit}		ΔH _{v,b}		ΔH _{v,TS}	H _{TS}	H' _{TS}	D ^{eff} _{VA}	D ^{eff} _{VB}	D ^{eff} _{VT}	D ^{eff} _{crack}	D ^{eff} _{CZ}	D ^{eff} _T	SDF
	Diffusivity in Air (cm ² /sec)	Diffusivity in Air (cm ² /sec) Source	Diffusivity in Water (cm ² /sec)	Diffusivity in Water (cm ² /sec) Source	Henry's Law Constant Reference Temperature (degrees C)	Henry's Law Constant Reference Temperature (degrees C) Source	Normal Boiling Point (degrees K)	Normal Boiling Point (degrees K) Source	Critical Temperature (degrees K)	Critical Temperature (degrees K) Source	Enthalpy of Vaporization at Normal Boiling Point (cal/mole)	Enthalpy of Vaporization at Normal Boiling Point (cal/mole) Source	Enthalpy of Vaporization at Avg GW Temp (cal/mole)	Henry's Law Constant at Avg GW Temp (atm-m ³ /mol)	Henry's Law Constant at Avg GW Temp (conc/conc)	Effective Diffusivity in Vadose Zone Layer A (adj to bldg) (cm ² /sec)	Effective Diffusivity in Vadose Zone Layer B (intermediate) (cm ² /sec)	Effective Diffusivity in Vadose Zone Total (cm ² /sec)	Effective Diffusivity in Crack (cm ² /sec)	Effective Diffusivity in Capillary Zone (cm ² /sec)	Effective Diffusivity Total (cm ² /sec)	Source Dilution Factor (unitless)
Carbon tetrachloride	0.078	7	8.8E-06	7	25	7	349.9	7	556.6	7	7127	7	7859	0.01366935	0.588373	0.0153911	0.015391099	0.0153911	0.015391	1.32E-03	5.69E-03	1
Chloroethane	0.271	7	1.15E-05	7	24	7	285.45	7	460.15	7	24.65	7	25	0.01107701	0.4767903	0.05347419	0.05347419	0.0534742	0.053474	4.57E-03	1.98E-02	1
Chloroform	0.104	7	0.00001	7	25	7	334.32	7	536.4	7	6988	7	7554	0.00186777	0.08039478	0.02052151	0.020521513	0.0205215	0.020522	1.76E-03	7.60E-03	1
Dichloroethane, 1,1-	0.0742	7	1.05E-05	7	25	7	330.55	7	523	7	6895	7	7450	0.00288694	0.12426307	0.01464131	0.014641309	0.0146413	0.014641	1.26E-03	5.42E-03	1
Dichloroethene, cis-1,2-	0.0736	7	1.13E-05	7	25	7	333.65	7	544	7	7192	7	7734	0.00204327	0.08794896	0.01452294	0.014522936	0.0145229	0.014523	1.25E-03	5.39E-03	1
Dichloroethene, 1,1-	0.09	7	1.04E-05	7	25	7	304.75	7	576.05	7	6247	7	6392	0.01473742	0.63434624	0.01775896	0.01775896	0.017759	0.017759	1.52E-03	6.56E-03	1
Tetrachloroethene	0.072	7	8.2E-06	7	25	7	394.4	7	620.2	7	8288	7	9553	0.0075339	0.32428336	0.01420717	0.014207173	0.0142072	0.014207	1.21E-03	5.25E-03	1
Trans-1,2-Dichloroethene	0.0707	7	1.19E-05	7	25	7	320.85	7	516.5	7	6717	7	7136	0.00495551	0.213301	0.01395067	0.013950669	0.0139507	0.013951	1.19E-03	5.16E-03	1
Trichloroethane, 1,1,1-	0.078	7	8.8E-06	7	25	7	347.24	7	545	7	7136	7	7885	0.00849864	0.36580874	0.0153911	0.015391103	0.0153911	0.015391	1.32E-03	5.69E-03	1
Trichloroethene	0.079	7	9.1E-06	7	25	7	360.36	7	544.2	7	7505	7	8557	0.00458318	0.19727504	0.01558843	0.015588435	0.0155884	0.015588	1.33E-03	5.77E-03	1
Vinyl chloride	0.106	7	1.23E-06	7	25	7	259.25	7	432	7	5250	7	5000	0.01777872	0.76525335	0.0209161	0.0209161	0.0209161	0.020916	1.79E-03	7.73E-03	1

Notes:
1 Syracuse Research Corporation (<http://www.syrres.com/esc/physdemo.htm>)
2 ATSDR, "Toxicological Profile for _____"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.
3 US EPA Soil Screening Guidance: Technical Background Document, EPA/540/R95/128, May 1996
4 OSHA Documentation of TLV -TWA
5 Measured Koc from the SSL Guidance, Table 39
5a Calculated Koc from the SSL Guidance, Table 39
6 <http://chemfinder.cambridgesoft.com>
7 Risk Assessment Information System (RAIS), <http://rais.oml.gov/>

Table RC-37
Comparison of Soil and Groundwater EPCs to UCLs
50 Tufts Street
Somerville, MA

	Massachusetts DEP Upper Concentration Limits		EPCs: Commercial Worker, Potential Future Resident, Construction Worker, Utility Worker, and Landscaper at the Property			EPCs: Residential Properties, Commercial Properties, and Construction workers on Alston Street Worst case			EPCs: Residents and Commercial Properties, and Construction Workers on Tufts Street Worst case		
	Soil	Groundwater	Soil	Soil	Groundwater	Soil	Soil	Groundwater	Soil	Soil	Groundwater
			Average 0-3'	Average 0-15'	Maximum of temporal averages	Maximum 0-3'	Maximum 0-15'	Maximum of temporal averages	Maximum 0-3'	Maximum 0-15'	Maximum of temporal averages
Compound	mg/kg	mg/L	mg/kg	mg/kg	mg/L	mg/kg	mg/kg	mg/L	mg/kg	mg/kg	mg/L
Carbon tetrachloride	4.0E+03	5.0E+01	4.7E-02	4.8E-02	1.4E-01	5.5E-02	4.5E-02	5.0E-04	8.0E-02	2.8E-02	5.0E-04
Chloroethane	NS	NS	1.2E-01	1.2E-01	2.5E-01	1.4E-01	1.1E-01	1.0E-03	2.0E-01	5.6E-02	1.0E-03
Chloroform	8.0E+03	1.0E+02	NA	NA	1.3E-01	5.5E-02	4.5E-02	5.0E-04	NA	2.8E-02	5.0E-04
Dichloroethane, 1,1-	1.0E+04	1.0E+02	NA	NA	1.5E-01	5.5E-02	4.5E-02	5.0E-04	8.5E-02	2.8E-02	1.3E-02
Dichloroethene, cis-1,2-	5.0E+03	1.0E+02	NA	NA	2.2E-01	5.5E-02	4.5E-02	5.0E-04	8.5E-02	2.8E-02	1.3E-02
Dichloroethene, 1,1-	1.0E+04	1.0E+02	NA	NA	3.1E+00	5.5E-02	4.5E-02	5.0E-04	8.5E-02	2.8E-02	1.3E-02
Tetrachloroethene	1.0E+04	1.0E+02	3.1E+00	1.1E+01	6.2E+01	5.5E-02	4.5E-02	5.3E-04	9.9E-02	3.2E-01	1.2E+01
Trans-1,2-Dichloroethene	1.0E+04	1.0E+02	4.7E-02	4.8E-02	1.3E-01	5.5E-02	4.5E-02	5.0E-04	8.0E-02	2.8E-02	5.0E-04
Trichloroethane, 1,1,1-	1.0E+04	1.0E+02	NA	NA	1.4E+02	5.5E-02	4.5E-02	5.0E-04	8.5E-02	8.0E-02	9.2E-02
Trichloroethene	1.0E+04	5.0E+01	6.7E-02	6.4E-02	1.1E+02	5.5E-02	4.5E-02	2.0E-03	8.0E-02	2.8E-02	1.0E-01
Vinyl chloride	3.0E+02	1.0E+02	4.7E-02	4.8E-02	1.3E-01	5.5E-02	4.5E-02	5.0E-04	8.0E-02	2.8E-02	5.0E-04

NA = no data were available for this compound in this medium
NS = No UCL value is available from MassDEP

Table RC-10

Risk Summary

Current Exposures: Commercial Worker at The Property

50 Tufts Street, Somerville, MA

UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	1.E-04	3.E-08
Soil particulate	1.E-06	3.E-10
Ambient Air (outdoor data)	3.E-03	2.E-06
Cumulative Risk without Indoor Air	3.E-03	3.E-06
Indoor Air Risks		
Office space	6.E-03	8.E-06
Warehouse and garage	6.E-03	8.E-06
Cumulative with Indoor Air		
Cumulative using average of 50 Tufts Outdoor Air (office average)	9.E-03	1.E-05
Cumulative using average of 50 Tufts Outdoor Air (warehouse and garage average)	9.E-03	1.E-05

Notes:

Highlighted Values are Total Cumulative Risks

Table RC-11
 Risk Summary
 Current Exposures: Landscaper at The Property
 50 Tufts Street, Somerville, MA
 UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	1.E-05	2.E-08
Soil particulate	2.E-07	4.E-10
Ambient Air (outdoor data)	6.E-04	6.E-07
Cumulative Risk	6.E-04	7.E-07

Notes:
 Highlighted Values are Total Cumulative Risks

Table RC-12
 Risk Summary
 Future Exposures: Future Resident at The Property
 50 Tufts Street, Somerville, MA
 UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	5.E-03	5.E-07
Soil particulate	4.E-06	1.E-09
Ambient Air (Outdoor data)	4.E-03	3.E-06
Cumulative Risk	9.E-03	4.E-06

Notes:
 Highlighted Values are Total Cumulative Risks

Table RC-13
Risk Summary
Future Exposures: Commercial Worker at The Property
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	4.E-04	8.E-08
Soil particulate	3.E-06	7.E-10
Ambient Air (outdoor data)	3.E-03	2.E-06
Cumulative Risk	3.E-03	3.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-14
Risk Summary
Future Exposures: Landscaper at The Property
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	3.E-05	6.E-08
Soil particulate	5.E-07	1.E-09
Ambient Air (outdoor data)	6.E-04	6.E-07
Cumulative Risk	6.E-04	7.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-15
Risk Summary
Future Exposures: Construction Worker at The Property
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	3.E-04	1.E-08
Soil particulate	5.E-06	2.E-10
Excavation Air (average of ambient air values predicted from soil, groundwater and soil vapor data)	6.E-01	1.E-05
Cumulative Risk	6.E-01	1.E-05

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-16
 Risk Summary
 Future Exposures: Utility Worker at The Property
 50 Tufts Street, Somerville, MA
 UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	1.E-06	5.E-10
Soil particulate	2.E-08	7.E-12
Groundwater ingestion and dermal	1.E-02	8.E-07
Trench Air (average of ambient air values predicted from soil, groundwater and soil vapor data)	1.E-02	1.E-06
Cumulative Risk	2.E-02	2.E-06

Notes:
 Highlighted Values are Total Cumulative Risks

Table RC-17
Risk Summary
Current and Future Exposures: Resident at 60 Tufts Street
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	6.E-04	9.E-08
Soil particulate	4.E-07	2.E-10
Ambient Air (outdoor data)	4.E-03	1.E-06
Cumulative Risk	4.E-03	1.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-18
Risk Summary
Future Exposures: Commercial Worker at 60 Tufts Street
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	4.E-05	1.E-08
Soil particulate	3.E-07	8.E-11
Ambient Air (outdoor air)	3.E-03	7.E-07
Cumulative Risk	3.E-03	7.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-19
Risk Summary
Future Exposures: Construction Worker at 60 Tufts Street
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	7.E-05	2.E-09
Soil particulate	1.E-06	2.E-11
Excavation Air (average of soil, groundwater and soil vapor)	3.E-04	9.E-09
Cumulative Risk	4.E-04	1.E-08

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-20
Risk Summary
Current Exposures: Resident in Alston Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	7.E-04	1.E-07
Soil particulate	5.E-07	2.E-10
Ambient Air (outdoor data)	4.E-03	6.E-07
Cumulative Outdoor Risk	4.E-03	7.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-21
Risk Summary
Future Exposures: Resident in Alston Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	5.E-04	8.E-08
Soil particulate	4.E-07	1.E-10
Ambient Air (outdoor data)	4.E-03	6.E-07
Cumulative Outdoor Risks	4.E-03	7.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-22
Risk Summary
Future Exposures: Commercial Worker in Alston Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	4.E-05	1.E-08
Soil particulate	3.E-07	7.E-11
Ambient Air (outdoor air)	3.E-03	4.E-07
Cumulative Outdoor Risk	3.E-03	4.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-23
Risk Summary
Future Exposures: Construction Worker in Alston Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	8.E-05	2.E-09
Soil particulate	1.E-06	2.E-11
Excavation Air (average of soil, groundwater and soil vapor)	2.E-04	3.E-09
Cumulative Risk	3.E-04	5.E-09

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-24

Risk Summary

Current Exposures: Resident in Tufts Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	9.E-04	1.E-07
Soil particulate	7.E-07	2.E-10
Ambient Air (outdoor air)	4.E-03	2.E-06
Cumulative Outdoor Risk	5.E-03	2.E-06

Notes:

Highlighted Values are Total Cumulative Risks

Table RC-25
Risk Summary
Future Exposures: Resident in Tufts Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	5.E-04	6.E-08
Soil particulate	4.E-07	1.E-10
Ambient Air (outdoor air)	4.E-03	2.E-06
Cumulative Outdoor Risks	4.E-03	2.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-26
Risk Summary
Future Exposures: Commercial in Tufts Street Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	3.E-05	1.E-08
Soil particulate	3.E-07	6.E-11
Ambient Air (average of outdoor air)	3.E-03	2.E-06
Cumulative Outdoor Risk	3.E-03	2.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-27
 Risk Summary
 Future Exposures: Construction Worker in Tufts Street Area
 50 Tufts Street, Somerville, MA
 UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	5.E-05	1.E-09
Soil particulate	8.E-07	1.E-11
Excavation Air (average of soil, groundwater and soil vapor)	3.E-03	1.E-06
Cumulative Risk	3.E-03	1.E-06

Notes:
 Highlighted Values are Total Cumulative Risks

Table RC-28

Risk Summary

Current Exposures: Resident in Other Streets Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	2.E-03	1.E-07
Soil particulate	1.E-06	3.E-10
Ambient Air (outdoor air)	4.E-03	7.E-07
Cumulative outdoor risks	6.E-03	8.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-29
Risk Summary
Current Exposures: Commercial Worker in Other Streets Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Outdoor Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	1.E-04	2.E-08
Soil particulate	1.E-06	1.E-10
Ambient Air (average of outdoor air)	3.E-03	5.E-07
Cumulative Outdoor Risks		
Cumulative using average of outdoor air	3.E-03	5.E-07
Indoor Air Risks for each property		
163 Glen Street	6.E-03	2.E-06
85 Washington Street	6.E-03	2.E-06
97 Washington Street (average)	6.E-03	2.E-06
121 Washington Street	6.E-03	2.E-06
Cummulative Indoor and Outdoor Risks at 163 Glen Street		
Cumulative using average of outdoor air	9.E-03	2.E-06
Cummulative Indoor and Outdoor Risks at 85 Washington		
Cumulative using average of outdoor air	9.E-03	2.E-06
Cummulative Indoor and Outdoor Risks at 97 Washington		
Cumulative using average of outdoor data	9.E-03	2.E-06
Cummulative Indoor and Outdoor Risks at 121 Washington		
Cumulative using average of outdoor data	9.E-03	2.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-30
Risk Summary
Current Exposures: Capuano School
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	2.E-03	3.E-08
Soil particulate	2.E-06	2.E-11
Ambient Air (outdoor air)	6.E-03	6.E-08
Cumulative outdoor risks	8.E-03	1.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-31
Risk Summary
Future Exposures: Resident in Other Streets Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	4.E-02	2.E-06
Soil particulate	3.E-05	7.E-09
Ambient Air (outdoor air)	4.E-03	7.E-07
Cumulative outdoor risks	4.E-02	3.E-06
Indoor Air Risks for each property		
163 Glen Street	3.E-02	8.E-06
85 Washington Street	3.E-02	7.E-06
97 Washington Street (ave)	3.E-02	8.E-06
121 Washington Street	3.E-02	8.E-06
Cummulative Indoor and Outdoor Risks at 163 Glen Street		
Cumulative Risk	7.E-02	1.E-05
Cummulative Indoor and Outdoor Risks at 85 Washington		
Cumulative Risk	7.E-02	1.E-05
Cummulative Indoor and Outdoor Risks at 97 Washington (using temp. weighted average)		
Cumulative Risk	7.E-02	1.E-05
Cummulative Indoor and Outdoor Risks at 121 Washington		
Cumulative Risk	7.E-02	1.E-05

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-32
Risk Summary
Future Exposures: Commercial Worker in Other Streets Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Outdoor Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	3.E-03	4.E-07
Soil particulate	2.E-05	4.E-09
Ambient Air (average of outdoor air)	3.E-03	5.E-07
Cumulative Outdoor Risks		
Cumulative using average of outdoor air	6.E-03	9.E-07
Indoor Air Risks for each property		
163 Glen Street	6.E-03	2.E-06
85 Washington Street	6.E-03	2.E-06
97 Washington Street (average)	6.E-03	1.E-06
121 Washington Street	6.E-03	2.E-06
Cummulative Indoor and Outdoor Risks at 163 Glen Street		
Cummulative using average of outdoor air	1.E-02	3.E-06
Cummulative Indoor and Outdoor Risks at 85 Washington		
Cummulative using average of outdoor air	1.E-02	2.E-06
Cummulative Indoor and Outdoor Risks at 97 Washington		
Cummulative using average of outdoor data	1.E-02	3.E-06
Cummulative Indoor and Outdoor Risks at 121 Washington		
Cummulative using average of outdoor data	1.E-02	3.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-33
Risk Summary
Future Exposures: Capuano School
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	6.E-02	6.E-07
Soil particulate	5.E-05	6.E-10
Ambient Air (outdoor air)	6.E-03	6.E-08
Cumulative Outdoor Risk	7.E-02	7.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-34
Risk Summary
Future Exposures: Construction Worker in Other Streets Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	2.E-03	6.E-08
Soil particulate	3.E-05	9.E-10
Excavation Air (average of soil, groundwater and soil vapor)	9.E-03	1.E-06
Cumulative Risk	1.E-02	1.E-06

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-35
Risk Summary
Future Exposures: Worst-case Utility Worker in Neighborhood Streets Area
50 Tufts Street, Somerville, MA
UniFirst Corporation

Exposure Pathways	Non-Carcinogenic Risk	Carcinogenic Risk
Soil ingestion and dermal	4.E-07	8.E-11
Soil particulate	6.E-09	1.E-12
Groundwater ingestion and dermal	4.E-04	1.E-07
Trench Air (average of ambient air values predicted from soil, groundwater and soil vapor data)	1.E-04	2.E-07
Cumulative Risk	5.E-04	3.E-07

Notes:
Highlighted Values are Total Cumulative Risks

Table RC-36
Risk Summary
50 Tufts Street, Somerville, MA
UniFirst Cooperation

Exposure Area	Receptor	Time	Non-Carcinogenic Risk	Carcinogenic Risk	Exposure Pathways
The Property	Resident	Future	9E-03	4E-06	a, b, c
	Commercial Worker	Current	3E-03	3E-06	a, b, c
			9E-03	1E-05	a, b, c, d1
			9E-03	1E-05	a, b, c, d2
		Future	3E-03	3E-06	a, b, c
	Construction Worker	Future	6E-01	1E-05	a, b, e
	Utility Worker	Future	2E-02	2E-06	a, b, e, g
	Landscaper	Current	6E-04	7E-07	a, b, c
		Future	6E-04	7E-07	a, b, c
60 Tufts Street Area	Resident	Current and Future	4E-03	1E-06	a, b, c
	Commercial Worker	Future	3E-03	7E-07	a, b, c
	Construction Worker	Future	4E-04	1E-08	a, b, e
Alston Street Area	Resident	Current	4E-03	7E-07	a, b, c
		Future	4E-03	7E-07	a, b, c
	Commercial Worker	Future	3E-03	4E-07	a, b, c
	Construction Worker	Future	3E-04	5E-09	a, b, e
Along Tufts Street Area	Resident	Current	4E-03	2E-06	a, b, c
		Future	4E-03	2E-06	a, b, c
	Commercial Worker	Future	3E-03	2E-06	a, b, c
	Construction Worker	Future	3E-03	1E-06	a, b, e
Other Streets Area (outdoor)	Resident	Current	6E-03	8E-07	a, b, c
		Future	4E-02	3E-06	a, b, c
	Commercial Worker	Current	3E-03	5E-07	a, b, c
		Future	6E-03	9E-07	a, b, c
	Construction Worker	Future	1E-02	1E-06	a, b, e
	Capuano School Student	Current	8E-03	1E-07	a, b, c
		Future	7E-02	7E-07	a, b, c
Other Streets Area (163 Glen Street)	Resident	Future	7E-02	1E-05	a, b, c, d3
	Commercial Worker	Current	9E-03	2E-06	a, b, c, d3
	Commercial Worker	Future	1E-02	3E-06	a, b, c, d3
Other Streets Area (85 Washington)	Resident	Future	7E-02	1E-05	a, b, c, d3
	Commercial Worker	Current	9E-03	2E-06	a, b, c, d3
	Commercial Worker	Future	1E-02	3E-06	a, b, c, d3
Other Streets Area (97 Washington)	Resident	Future	7E-02	1E-05	a, b, c, d3
	Commercial Worker	Current	9E-03	2E-06	a, b, c, d3
	Commercial Worker	Future	1E-02	3E-06	a, b, c, d3
Other Streets Area (121 Washington)	Resident	Future	7E-02	1E-05	a, b, c, d3
	Commercial Worker	Current	9E-03	2E-06	a, b, c, d3
	Commercial Worker	Future	1E-02	3E-06	a, b, c, d3
Within Neighborhood Streets Area	Utility Worker	Future	5E-04	3E-07	a, b, f, g

Notes:

- (a) Soil, ingestion and dermal contact
- (b) Soil, inhalation and ingestion of particulates
- (c) Air, ambient
- (d) Air, indoor
- (e) Air, excavation
- (f) Air, trench
- (g) Groundwater, ingestion and dermal contact
- (1) office indoor air
- (2) warehouse and garage indoor air
- (3) property indoor air

Table RC-37
Comparison of Soil and Groundwater EPCs to UCLs
50 Tufts Street
Somerville, MA

	Massachusetts DEP Upper Concentration Limits		EPCs: Residential Properties, Commercial Properties, and Construction on Other Streets* Worst case			EPCs: Residential Properties, Commercial Properties, and Construction workers on 60 Tufts Street Worst case		EPCs: Utility Worker within Neighborhood Streets Worst case	
	Soil	Groundwater	Soil	Soil	Groundwater	Soil	Groundwater	Soil	Groundwater
					Maximum of temporal averages		Maximum of temporal averages		Maximum of temporal averages
Compound	mg/kg	mg/L	Maximum 0-3' mg/kg	Maximum 0-15' mg/kg	mg/L	Maximum 0-15' mg/kg	mg/L	Maximum 0-6' mg/kg	mg/L
Carbon tetrachloride	4.0E+03	5.0E+01	4.9E-02	3.7E-02	5.0E-04	4.8E-02	5.0E-04	2.8E-02	5.0E-04
Chloroethane	NS	NS	1.2E-01	9.5E-02	1.5E-02	1.2E-01	1.0E-03	5.6E-02	1.0E-03
Chloroform	8.0E+03	1.0E+02	4.9E-02	3.7E-02	8.9E-03	NA	5.0E-04	2.8E-02	1.3E-02
Dichloroethane, 1,1-	1.0E+04	1.0E+02	1.3E-01	4.3E-01	7.7E-02	4.8E-02	4.9E-04	1.3E-01	4.9E-02
Dichloroethene, cis-1,2-	5.0E+03	1.0E+02	4.9E-02	7.7E-01	2.0E-01	4.8E-02	5.0E-04	2.8E-02	6.6E-02
Dichloroethene, 1,1-	1.0E+04	1.0E+02	4.9E-02	4.9E-01	4.3E-02	4.8E-02	4.2E-03	2.8E-02	2.9E-02
Tetrachloroethene	1.0E+04	1.0E+02	9.9E-01	5.9E+01	6.7E+00	1.8E-01	2.9E-02	9.9E-01	1.2E+01
Trans-1,2-Dichloroethene	1.0E+04	1.0E+02	4.9E-02	3.7E-02	7.6E-03	4.8E-02	5.0E-04	2.8E-02	1.3E-02
Trichloroethane, 1,1,1-	1.0E+04	1.0E+02	7.7E-02	7.7E-02	9.1E-02	4.8E-02	1.8E-02	7.7E-02	9.2E-02
Trichloroethene	1.0E+04	5.0E+01	3.6E-01	6.2E+00	1.5E-01	3.4E-02	6.0E-03	3.6E-01	1.4E-01
Vinyl chloride	3.0E+02	1.0E+02	4.9E-02	3.7E-02	5.8E-02	4.8E-02	5.0E-04	2.8E-02	1.3E-02

NA = no data were available for this compound in this medium
NS = No UCL value is available from MassDEP

ATTACHMENT A
RISK CALCULATIONS

Table A-1
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at 50 Tufts St.
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Current
Depth:	0-3 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IR _{soil}	Soil Ingestion Rate	mg/d	50	
IR _{soil} TWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-cf	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPC	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{soil} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{de} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total				
				RAF _{osc}	ADD _{ing-c} mg/kg-d	Risk _{ing}	RAF _{dsc}	ADD _{der-c} mg/kg-d	Risk _{der}	ADD _{der-nc} mg/kg-d	Hlder	Risk (Soil) YC-OC-A	HI (Soil) YC	
Carbon tetrachloride	0.04725	0.0007	0.13	1	4.90E-09	6.37E-10	1	1.27E-08	1.82E-05	0.1	2.65E-09	3.78E-06	7.70E-10	2.19E-05
Chloroethane	0.11875	0.4	NA	NC	NA	NA	1	3.19E-08	7.99E-08	NC	6.66E-09	1.66E-08	NA	9.65E-08
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	0.1	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	0.01	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	0.01	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	NA	NA
Tetrachloroethene	3.07735	0.01	0.051	1	3.19E-07	1.63E-08	1	8.28E-07	8.28E-05	0.1	1.73E-07	1.73E-05	1.97E-08	1.00E-04
Trans-1,2-Dichloroethene	0.04725	0.02	NA	NC	NA	NA	1	1.27E-08	6.36E-07	NC	2.65E-09	1.32E-07	NA	7.68E-07
Trichloroethane, 1,1,1-	NA	0.09	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	NA	NA
Trichloroethene	0.066625	0.002	0.011	1	6.91E-09	7.61E-11	1	1.79E-08	8.96E-06	0.1	3.74E-09	1.87E-06	9.19E-11	1.08E-05
Vinyl chloride	0.04725	0.003	1.4	1.53	7.50E-09	1.05E-08	1	1.27E-08	4.24E-06	0.16	2.65E-09	8.83E-07	1.28E-08	5.12E-06
Total						2.75E-08			1.15E-04			2.39E-05	3.33E-08	1.39E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-2
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Current Commercial Worker at 50 Tufts St.
Ambient Air

Receptor:
Medium of Origin:
Exposure Medium:
Exposure Area:
Depth:
Duration:

Commercial/Industrial Worker

Soil

Ambient Air

Current

0-3 feet

Chronic

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-yh-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	120	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFire	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hiling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.04725	1.51E-09	0.43	0.000015	0.0007	0.13	1	1.506E-11	5.272E-11	7.91E-13	4.519E-11	5.87E-12	1	3.91E-11	1.37E-10	3.18E-10	1.17E-10	1.67E-07	6.67E-12	1.68E-07
Chloroethane	0.11875	3.80E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	9.81E-11	3.44E-10	3.44E-11	2.94E-10	7.36E-10	NA	7.70E-10
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	NA	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	NA	0.2	NA	0.05	NA	1	9.81E-10	3.434E-09	3.43E-11	2.943E-09	1.50E-10	1	2.54E-09	8.90E-09	1.94E-09	7.63E-09	7.63E-07	1.84E-10	7.65E-07
Tetrachloroethene	3.07735	9.85E-08	4.6	0.00001	0.01	0.051	1	NA	NA	NA	NA	NA	1	3.91E-11	1.37E-10	1.95E-09	1.17E-10	5.86E-09	NA	7.81E-09
Trans-1,2-Dichloroethene	0.04725	1.51E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	NA	5.2	NA	0.09	NA	1	2.124E-11	7.434E-11	1.26E-13	6.372E-11	7.01E-13	1	5.51E-11	1.93E-10	1.07E-09	1.65E-10	8.26E-08	8.27E-13	8.37E-08
Trichloroethene	0.066625	2.13E-09	0.18	0.0000017	0.002	0.011	1	1.506E-11	5.272E-11	4.64E-13	4.519E-11	6.33E-11	1	3.91E-11	1.37E-10	1.37E-09	1.17E-10	3.91E-08	6.37E-11	4.04E-08
Vinyl chloride	0.04725	1.51E-09	0.1	0.0000088	0.003	1.4	1			3.57E-11		2.20E-10				6.68E-09		1.06E-06	2.56E-10	1.07E-06
Total																				

NA - Not available
NC - Not calculated
ND - Not detected

Table A-3
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at 50 Tufts St.
Ambient Air

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Ambient Air
Exposure Medium:	Ambient Air
Exposure Area:	Current
Depth:	Shallow
Duration:	Chronic

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.44E-05	8.88E-05	NA	8.88E-05
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	4.33E-05	1.24E-03	NA	1.24E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	4.33E-05	2.16E-04	NA	2.16E-04
Tetrachloroethene	5.50E-03	4.6	0.00001	1	2.32E-04	2.32E-06	1	6.03E-04	1.31E-04	2.32E-06	1.31E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	4.33E-05	6.18E-04	NA	6.18E-04
Trichloroethane, 1,1,1-	8.77E-04	5.2	NA	NC	NA	NA	1	9.61E-05	1.85E-05	NA	1.85E-05
Trichloroethene	6.93E-04	0.18	0.0000017	1	2.93E-05	4.98E-08	1	7.59E-05	4.22E-04	4.98E-08	4.22E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.08E-05	9.49E-08	1	2.79E-05	2.79E-04	9.49E-08	2.79E-04
Total						2.47E-06			3.01E-03	2.47E-06	3.01E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-4
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at 50 Tufts St.
Indoor Air
50 Tufts Office (NO & SO)

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	50 Tufts Office (NO & SO)
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF1}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC	RIC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Indoor Air)	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	9.25E-05	1.85E-04	NA	1.85E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	9.02E-05	2.58E-03	NA	2.58E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	9.02E-05	4.51E-04	NA	4.51E-04
Tetrachloroethene	8.20E-03	4.6	0.00001	1	7.22E-04	7.22E-06	1	1.87E-03	4.07E-04	7.22E-06	4.07E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	9.02E-05	1.29E-03	NA	1.29E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	1.26E-04	2.41E-05	NA	2.41E-05
Trichloroethene	5.50E-04	0.18	0.0000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08	6.98E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07	5.82E-04
Total						7.50E-06			6.21E-03	7.50E-06	6.21E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-5
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at 50 Tufts St.
Indoor Air
50 Tufts Warehouse and garage

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	50 Tufts Warehouse and garage
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFIc	ADE-c mg/m3	Riskinh	RAFInc	ADE-nc mg/m3	HIinh	Risk (Indoor Air)	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	9.25E-05	1.85E-04	NA	1.85E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	9.02E-05	2.58E-03	NA	2.58E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	NC	NA	NA	1	9.02E-05	4.51E-04	NA	4.51E-04
Tetrachloroethene	8.31E-03	4.6	0.00001	1	7.32E-04	7.32E-06	1	1.90E-03	4.12E-04	7.32E-06	4.12E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	9.02E-05	1.29E-03	NA	1.29E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	1.26E-04	2.41E-05	NA	2.41E-05
Trichloroethene	5.50E-04	0.18	0.000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08	6.98E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07	5.82E-04
Total						7.60E-06			6.22E-03	7.60E-06	6.22E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-6
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
Unifirst
Current Landscaper at 50 Tufts St.
Soil

Receptor:	Landscaper
Medium:	Soil
Exposure Area:	Current
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-ci	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.19	
EF	Soil Exposure Frequency	d/y	30.4	
EPC	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{ox} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFosc	ADDing-c mg/kg-d	Risking	RAFoscnc	ADDing-nc mg/kg-d	Hiling	Dermal Contact RAFdsnc	ADDder-c mg/kg-d	Riskder	RAFdsnc	ADDder-nc mg/kg-d	Hider	Total Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.04725	0.007	0.13	1	2.62E-09	3.40E-10	1	6.79E-09	9.69E-07	0.1	1.73E-09	2.25E-10	0.1	4.48E-09	6.40E-07	5.65E-10	1.61E-06
Chloroethane	0.11875	0.4	NA	NC	NA	NA	1	1.71E-08	4.26E-08	NC	NA	NA	0.1	1.13E-08	2.81E-08	NA	7.08E-08
Chloroform	NA	0.01	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	0.13	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	1	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	0.1	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Tetrachloroethene	3.07735	0.05	0.051	1	1.70E-07	8.69E-09	1	4.42E-07	4.42E-06	0.1	1.12E-07	5.74E-09	0.1	2.92E-07	2.92E-06	1.44E-08	7.34E-06
Trichloroethene	0.04725	0.1	NA	NC	NA	NA	1	6.79E-09	3.39E-08	NC	NA	NA	0.1	4.48E-09	2.24E-08	NA	5.63E-08
Trans-1,2-Dichloroethene	NA	0.2	NA	1	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Trichloroethane, 1,1,1-	0.066625	0.9	0.011	1	3.69E-09	4.06E-11	1	9.57E-09	4.78E-07	0.1	2.44E-09	2.68E-11	0.1	6.31E-09	3.16E-07	6.74E-11	7.94E-07
Vinyl chloride	0.04725	0.003	1.4	1.53	4.00E-09	5.61E-09	1	6.79E-09	2.26E-06	0.16	2.76E-09	3.87E-09	0.1	4.48E-09	1.49E-06	9.47E-09	3.75E-06
Total						1.47E-08			8.20E-06			9.86E-09			5.41E-06	2.45E-08	1.36E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-7
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Current Landscaper at 50 Tufts St.
Ambient Air

Receptor:	Landscaper
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Current
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	30	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gt} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$

$$HI = \frac{ADD_{inh-gt}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-gt} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFiC	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFiC	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.04725	2.84E-09	0.43	0.000015	0.007	0.13	1	2.261E-11	7.914E-11	1.19E-12	6.784E-11	8.82E-12	1	5.86E-11	2.05E-10	4.77E-10	1.76E-10	2.51E-08	1.00E-11	2.56E-08
Chloroethane	0.11875	7.13E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.47E-10	5.16E-10	5.16E-11	4.42E-10	1.10E-09	NA	1.16E-09
Chloroform	NA	NA	0.66	0.000023	0.01	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	NA	0.035	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	NA	0.2	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	3.82E-09	1.34E-08	2.91E-09	1.15E-08	1.15E-07	2.77E-10	1.17E-07
Tetrachloroethene	3.07735	1.85E-07	4.6	0.00001	0.1	0.051	1	1.473E-09	5.154E-09	5.15E-11	4.418E-09	2.25E-10	1	5.86E-11	2.05E-10	2.93E-10	1.76E-10	8.79E-10	NA	1.17E-09
Trans-1,2-Dichloroethene	0.04725	2.84E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	5.86E-11	2.05E-10	1.61E-09	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	NA	5.2	NA	0.9	NA	1	3.188E-11	1.116E-10	1.90E-13	9.565E-11	1.05E-12	1	8.27E-11	2.89E-10	1.61E-09	2.48E-10	1.24E-08	1.24E-12	1.40E-08
Trichloroethene	0.066825	4.00E-09	0.18	0.0000017	0.02	0.011	1	2.261E-11	7.914E-11	6.96E-13	6.784E-11	9.50E-11	1	5.86E-11	2.05E-10	2.05E-09	1.76E-10	5.86E-08	9.57E-11	6.07E-08
Vinyl chloride	0.04725	2.84E-09	0.1	0.0000088	0.003	1.4	1	2.261E-11	7.914E-11	5.38E-11	6.784E-11	3.30E-10	1	5.86E-11	2.05E-10	7.39E-09	2.13E-07	3.84E-10	3.84E-10	2.20E-07
Total																				

NA - Not available
NC - Not calculated
ND - Not detected

Table A-8
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Landscaper at 50 Tufts St.
Ambient Air

Receptor:	Landscaper	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	Shallow	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	30.4	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	5	NA	NC	NA	NA	1	1.12E-05	2.25E-06	NA	2.25E-06
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	1.10E-05	3.13E-04	NA	3.13E-04
Dichloroethene, 1,1-	3.95E-04	0.2	NA	NC	NA	NA	1	1.10E-05	5.48E-05	NA	5.48E-05
Tetrachloroethene	5.50E-03	4.6	0.00001	1	5.89E-05	5.89E-07	1	1.53E-04	3.32E-05	5.89E-07	3.32E-05
Trans-1,2-Dichloroethene	3.95E-04	0.7	NA	NC	NA	NA	1	1.10E-05	1.57E-05	NA	1.57E-05
Trichloroethane, 1,1,1-	8.77E-04	5.2	NA	NC	NA	NA	1	2.44E-05	4.68E-06	NA	4.68E-06
Trichloroethene	6.93E-04	0.18	0.000017	1	7.42E-06	1.26E-08	1	1.92E-05	1.07E-04	1.26E-08	1.07E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.73E-06	2.40E-08	1	7.08E-06	7.08E-05	2.40E-08	7.08E-05
Total						6.25E-07			6.02E-04	6.25E-07	6.02E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-9
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Resident at 50 Tufts St.
Soil

Receptor:	Resident
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm2/d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-ci	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPC	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der-nc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{os} \times EF}{AP}$$

$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{ds} \times EF}{AP}$$

$$HI_{ing} = \frac{ADD_{ing-nc}}{RfD}$$

$$HI_{der} = \frac{ADD_{der-nc}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing-c} \times CSF$$

$$Risk_{der} = ADD_{der-c} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling	Dermal Contact RAFdsnc	ADDder-c mg/kg-d	Riskder	RAFdsnc	ADDder-nc mg/kg-d	Hider	Total Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.0477	0.0007	0.13	1	1.78E-08	2.31E-09	1	1.15E-07	1.65E-04	0.1	1.85E-08	2.40E-09	0.1	9.81E-08	1.40E-04	4.72E-09	3.05E-04
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	2.90E-07	7.25E-07	NC	NA	NA	0.1	2.47E-07	6.17E-07	NA	1.34E-06
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NC	NA	NA	0.13	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	0.1	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	0.01	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, 1,1,1-	NA	0.05	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Tetrachloroethene	11.10188	0.01	0.051	1	4.14E-06	2.11E-07	1	2.68E-05	2.68E-03	0.1	4.30E-06	2.19E-07	0.1	2.28E-05	2.28E-03	4.31E-07	4.97E-03
Trans-1,2-Dichloroethene	0.0477	0.02	NA	NC	NA	NA	1	1.15E-07	5.77E-06	NC	NA	NA	0.1	9.81E-08	4.91E-06	NA	1.07E-05
Trichloroethane, 1,1,1-	NA	0.09	NA	NC	NA	NA	1	1.54E-07	7.72E-05	NC	NA	NA	0.1	1.31E-07	6.57E-05	NA	NA
Trichloroethene	0.06388	0.002	0.011	1	2.38E-08	2.62E-10	1	1.15E-07	3.84E-05	0.1	2.47E-08	2.72E-10	0.1	9.81E-08	3.27E-05	5.34E-10	1.43E-04
Vinyl chloride	0.0477	0.003	1.4	1.53	2.72E-08	3.81E-08	1	1.15E-07	3.84E-05	0.16	2.95E-08	4.14E-08	0.1	9.81E-08	3.27E-05	7.95E-08	7.11E-05
Total						2.52E-07			2.97E-03			2.63E-07			2.53E-03	5.15E-07	5.50E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-10
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Future Resident at 50 Tufts St.
Ambient Air

Receptor:	Resident
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$

$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inh-c mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0477	1.53E-09	0.43	0.000015	0.0007	0.13	1	2.144E-11	7.504E-11	1.13E-12	8.576E-11	2.28E-07	1.23E-11	2.28E-07
Chloroethane	0.12	3.84E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	1.00E-09	NA	1.05E-09
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	NA	0.035	NA	0.01	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	0.2	NA	0.05	NA	1	1.24E-08	4.33E-08	9.41E-09	3.71E-06	3.71E-06	1.19E-09	3.72E-06
Tetrachloroethene	11.10188	3.55E-07	4.6	0.00001	0.01	0.051	1	5.31E-11	1.86E-10	2.66E-09	1.59E-10	7.97E-09	1.19E-09	1.06E-08
Trans-1,2-Dichloroethene	0.0477	1.53E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	NA	5.2	NA	0.09	NA	1	7.12E-11	2.49E-10	1.38E-09	2.13E-10	1.07E-07	1.43E-12	1.08E-07
Trichloroethene	0.06388	2.04E-09	0.18	0.0000017	0.002	0.011	1	5.31E-11	1.86E-10	1.86E-09	1.59E-10	5.31E-08	1.21E-10	5.50E-08
Vinyl chloride	0.0477	1.53E-09	0.1	0.0000088	0.003	1.4	1	1.55E-09	1.58E-08	1.58E-08	1.58E-08	4.11E-06	1.33E-09	4.12E-06
Total														

NA - Not available
NC - Not calculated
ND - Not detected

Table A-11

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Future Resident at 50 Tufts St.
 Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	5.55E-05	1.11E-04	NA	1.11E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	5.41E-05	1.55E-03	NA	1.55E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	5.41E-05	2.71E-04	NA	2.71E-04
Tetrachloroethene	5.50E-03	4.6	0.00001	1	3.23E-04	3.23E-06	1	7.53E-04	1.64E-04	3.23E-06	1.64E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	5.41E-05	7.73E-04	NA	7.73E-04
Trichloroethane, 1,1,1-	8.77E-04	5.2	NA	NC	NA	NA	1	1.20E-04	2.31E-05	NA	2.31E-05
Trichloroethene	6.93E-04	0.18	0.0000017	1	4.07E-05	6.91E-08	1	9.49E-05	5.27E-04	6.91E-08	5.27E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.50E-05	1.32E-07	1	3.49E-05	3.49E-04	1.32E-07	3.49E-04
Total						3.43E-06			3.76E-03	3.43E-06	3.76E-03

NA - Not available

NC - Not calculated

ND - Not detected

Table A-12
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker at 50 Tufts St.
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	50	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-ci	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPC	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFosc	ADDing-c mg/kg-d	Risking	RAFoscnc	ADDing-nc mg/kg-d	Hling	Dermal Contact RAFdsc	ADDder-c mg/kg-d	Riskder	RAFdscnc	ADDder-nc mg/kg-d	Hlder	Total Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.0477	0.0007	0.13	1	4.95E-09	6.43E-10	1	1.28E-08	1.83E-05	0.1	1.03E-09	1.34E-10	0.1	2.67E-09	3.82E-06	7.78E-10	2.22E-05
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	3.23E-08	8.07E-08	NC	NA	NA	0.1	6.73E-09	1.68E-08	NA	9.75E-08
Chloroform	NA	0.01	NA	NC	NA	NA	1	NA	NA	NA	NA	NA	0.13	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	0.1	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	0.01	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	0.05	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Tetrachloroethene	11.10188	0.01	0.051	1	1.15E-06	5.88E-08	1	2.99E-06	2.99E-04	0.1	2.40E-07	1.22E-08	0.1	6.22E-07	6.22E-05	7.10E-08	3.61E-04
Trans-1,2-Dichloroethene	0.0477	0.02	NA	NC	NA	NA	1	1.28E-08	6.42E-07	NC	NA	NA	0.1	2.67E-09	1.34E-07	NA	7.75E-07
Trichloroethane, 1,1,1-	NA	0.09	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Trichloroethene	0.06388	0.002	0.011	1	6.63E-09	7.29E-11	1	1.72E-08	8.59E-06	0.1	1.38E-09	1.52E-11	0.1	3.58E-09	1.79E-06	8.81E-11	1.04E-05
Vinyl chloride	0.0477	0.003	1.4	1.53	7.57E-09	1.06E-08	1	1.28E-08	4.28E-06	0.16	1.65E-09	2.31E-09	0.1	2.67E-09	8.91E-07	1.29E-08	5.17E-06
Total						7.01E-08			3.31E-04			1.47E-08		6.89E-05		8.48E-08	4.00E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-13
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Future Commercial Worker at 50 Tufts St
Ambient Air

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gt} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$

$$HI = \frac{ADD_{inh-gt}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-gt} \times CSF) + (ADE_{inh} \times URF \times C)$$

Parameter	Definition	Units	Value	Comment
IR _{Air}	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IR _{Air} TWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	120	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

Compound	Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inh mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFin	ADD-inhnc mg/kg-d	ADE-nc mg/m3	Hinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0477	1.53E-09	0.43	0.000015	0.0007	0.13	1	1.521E-11	5.322E-11	7.98E-13	4.562E-11	5.93E-12	1	3.94E-11	1.38E-10	3.21E-10	1.18E-10	1.69E-07	1.69E-07	
Chloroethane	0.12	3.84E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	9.92E-11	3.47E-10	3.47E-11	2.98E-10	7.44E-10	7.79E-10	
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
Dichloroethane, 1,1-	NA	NA	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
Dichloroethane, cis-1,2-	NA	NA	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
Dichloroethane, 1,1-	NA	NA	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
Tetrachloroethene	11.10188	3.55E-07	4.6	0.00001	0.01	0.051	1	3.539E-09	1.239E-08	1.24E-10	1.062E-08	5.41E-10	1	9.18E-09	3.21E-08	6.98E-09	2.75E-08	2.75E-06	2.75E-06	
Trans-1,2-Dichloroethane	0.0477	1.53E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	3.94E-11	1.38E-10	1.97E-09	1.18E-10	5.91E-09	7.88E-09	
Trichloroethane, 1,1,1-	NA	NA	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
Trichloroethene	0.06388	2.04E-09	0.18	0.0000017	0.002	0.011	1	2.036E-11	7.127E-11	1.21E-13	6.109E-11	6.72E-13	1	5.28E-11	1.85E-10	1.03E-09	1.58E-10	7.92E-08	8.02E-08	
Vinyl chloride	0.0477	1.53E-09	0.1	0.0000088	0.003	1.4	1	1.521E-11	5.322E-11	4.68E-13	4.562E-11	6.39E-11	1	3.94E-11	1.38E-10	1.38E-09	1.18E-10	3.94E-08	4.08E-08	
Total										1.25E-10		6.12E-10				1.17E-08		3.05E-06	3.06E-06	

NA - Not available
NC - Not calculated
ND - Not detected

Table A-14
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker at 50 Tufts St.
Ambient Air

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Ambient Air
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	Shallow
Duration:	Chronic

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.44E-05	8.88E-05	NA	8.88E-05
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	4.33E-05	1.24E-03	NA	1.24E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	4.33E-05	2.16E-04	NA	2.16E-04
Tetrachloroethene	5.50E-03	4.6	0.00001	1	2.32E-04	2.32E-06	1	6.03E-04	1.31E-04	2.32E-06	1.31E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	4.33E-05	6.18E-04	NA	6.18E-04
Trichloroethane, 1,1,1-	8.77E-04	5.2	NA	NC	NA	NA	1	9.61E-05	1.85E-05	NA	1.85E-05
Trichloroethene	6.93E-04	0.18	0.0000017	1	2.93E-05	4.98E-08	1	7.59E-05	4.22E-04	4.98E-08	4.22E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.08E-05	9.49E-08	1	2.79E-05	2.79E-04	9.49E-08	2.79E-04
Total						2.47E-06			3.01E-03	2.47E-06	3.01E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-15
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Landscaper at 50 Tufts St.
Soil

Receptor:	Landscaper
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-ci	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.19	
EF	Soil Exposure Frequency	d/y	30.4	
EPc	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{dt} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil) YC-OC-A	HI (Soil) YC		
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling			RAFdsnc	ADDder-nc mg/kg-d
Carbon tetrachloride	0.0477	0.007	0.13	1	2.64E-09	3.43E-10	1	6.85E-09	9.79E-07	0.1	1.74E-09	5.70E-10	1.62E-06
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	1.72E-08	4.31E-08	NC	NA	NA	7.15E-08
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	1	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	NA
Dichloroethene, cis-1,2-	NA	0.1	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	NA
Dichloroethene, 1,1-	NA	0.05	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	NA
Tetrachloroethene	11.10188	0.1	0.051	1	6.15E-07	3.14E-08	1	1.59E-06	1.59E-05	0.1	4.06E-07	5.21E-08	2.65E-05
Trans-1,2-Dichloroethene	0.0477	0.2	NA	NC	NA	NA	1	6.85E-09	3.42E-08	NC	NA	NA	5.68E-08
Trichloroethane, 1,1,1-	NA	0.9	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	NA
Trichloroethene	0.06388	0.02	0.011	1	3.54E-09	3.89E-11	1	9.17E-09	4.59E-07	0.1	2.33E-09	6.46E-11	7.61E-07
Vinyl chloride	0.0477	0.003	1.4	1.53	4.04E-09	5.66E-09	1	6.85E-09	2.28E-06	0.16	2.79E-09	9.56E-09	3.79E-06
Total						3.74E-08			1.97E-05		2.49E-08	6.23E-08	3.28E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-16
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Future Landscaper at 50 Tufts St.
Ambient Air

Receptor:	Landscaper
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRair TWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	30	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-g} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$

$$HI = \frac{ADD_{inh-g}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-g} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFc	ADD-inhc mg/kg-d	ADE-c mg/m3	Hlinh	ADD-ingc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0477	2.86E-09	0.43	0.000015	0.007	0.13	1	2.283E-11	7.989E-11	1.20E-12	6.848E-11	8.90E-12	1	5.92E-11	2.07E-10	4.82E-10	1.78E-10	2.54E-08	1.01E-11	2.58E-08
Chloroethane	0.12	7.20E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.49E-10	5.21E-10	5.21E-11	4.47E-10	1.12E-09	NA	1.17E-09
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	NA	0.035	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	NA	0.2	NA	0.05	NA	1	5.313E-09	1.86E-08	1.86E-10	1.594E-08	8.13E-10	1	1.38E-08	4.82E-08	1.05E-08	4.13E-08	4.13E-07	9.99E-10	4.24E-07
Tetrachloroethene	11.10188	6.66E-07	4.6	0.00001	0.1	0.051	1	NA	NA	NA	NA	NA	1	5.92E-11	2.07E-10	2.96E-10	1.78E-10	8.88E-10	NA	1.18E-09
Trans-1,2-Dichloroethene	0.0477	2.86E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	NA	5.2	NA	0.9	NA	1	3.057E-11	1.07E-10	1.82E-13	9.17E-11	1.01E-12	1	7.93E-11	2.77E-10	1.54E-09	2.38E-10	1.19E-08	1.19E-12	1.34E-08
Trichloroethene	0.06388	3.83E-09	0.18	0.0000017	0.02	0.011	1	2.283E-11	7.989E-11	7.03E-13	6.848E-11	9.59E-11	1	5.92E-11	2.07E-10	2.07E-09	1.78E-10	5.92E-08	9.66E-11	6.13E-08
Vinyl chloride	0.0477	2.86E-09	0.1	0.0000088	0.003	1.4	1	2.283E-11	7.989E-11	1.88E-10	1.49E-08	9.19E-10	1	5.92E-11	2.07E-10	1.49E-08	5.12E-07	1.11E-09	5.27E-07	5.27E-07
Total																				

NA - Not available
NC - Not calculated
ND - Not detected

Table A-17
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Landscaper at 50 Tufts St.
Ambient Air

Receptor:	Landscaper	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	30.4	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane,1,1-	4.05E-04	5	NA	NC	NA	NA	1	1.12E-05	2.25E-06	NA	2.25E-06
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	1.10E-05	3.13E-04	NA	3.13E-04
Dichloroethene,1,1-	3.95E-04	0.2	NA	1	NA	NA	1	1.10E-05	5.48E-05	NA	5.48E-05
Tetrachloroethene	5.50E-03	4.6	0.00001	1	5.89E-05	5.89E-07	1	1.53E-04	3.32E-05	5.89E-07	3.32E-05
Trans-1,2-Dichloroethene	3.95E-04	0.7	NA	NC	NA	NA	1	1.10E-05	1.57E-05	NA	1.57E-05
Trichloroethane,1,1,1-	8.77E-04	5.2	NA	NC	NA	NA	1	2.44E-05	4.68E-06	NA	4.68E-06
Trichloroethene	6.93E-04	0.18	0.0000017	1	7.42E-06	1.26E-08	1	1.92E-05	1.07E-04	1.26E-08	1.07E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.73E-06	2.40E-08	1	7.08E-06	7.08E-05	2.40E-08	7.08E-05
Total						6.25E-07			6.02E-04		6.02E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-18

Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 50 Tufts St.
Soil - Dermal Contact & Incidental Ingestion
0-15 feet

Receptor:	Construction Worker
Medium:	Surface Soil
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{sa} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{dt} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.29	
EF	Soil Exposure Frequency	d/y	130	
EP	Soil Exposure Period - Cancer	y	1	
EP	Soil Exposure Period - Non-Cancer	y	1	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	182	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

Compound	EPC Contact & Incidental Ingestion 0-15 (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact				Total						
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling	RAFDsc	ADDder-c mg/kg-d	Riskder	RAFDsnc	ADDder-nc mg/kg-d	Hlder	Risk (Soil)	HI (Soil)
Carbon tetrachloride	0.0477	0.007	0.13	1	4.18E-10	5.44E-11	1	5.87E-08	8.39E-06	0.1	4.21E-10	5.48E-11	0.1	5.92E-08	8.45E-06	1.09E-10	1.68E-05
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	1.48E-07	3.69E-07	NC	NA	NA	0.1	1.49E-07	3.72E-07	NA	7.42E-07
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	1	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	0.13	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	0.1	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	0.05	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Tetrachloroethene	11.10188	0.1	0.051	1	9.74E-08	4.97E-09	1	1.37E-05	1.37E-04	0.1	9.81E-08	5.00E-09	0.1	1.38E-05	1.38E-04	9.97E-09	2.74E-04
Trans-1,2-Dichloroethene	0.0477	0.2	NA	NC	NA	NA	1	5.87E-08	2.94E-07	NC	NA	NA	0.1	5.92E-08	2.96E-07	NA	5.90E-07
Trichloroethane, 1,1,1-	NA	0.9	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	NA
Trichloroethene	0.06388	0.02	0.011	1	5.60E-10	6.16E-12	1	7.87E-08	3.93E-06	0.1	5.64E-10	6.21E-12	0.1	7.92E-08	3.96E-06	1.24E-11	7.90E-06
Vinyl chloride	0.0477	0.003	1.4	1.53	6.40E-10	8.96E-10	1	5.87E-08	1.96E-05	0.16	6.74E-10	9.44E-10	0.1	5.92E-08	1.97E-05	1.84E-09	3.93E-05
Total						5.92E-09			1.69E-04			6.01E-09			1.71E-04	1.19E-08	3.40E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-19
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Construction Worker at 50 Tufts St.
Ambient Air
Excavation
0-15 feet

Receptor:	Construction Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$

$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	130	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	182	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil Excavation 0-15 feet (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinc	ADD-irhnc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	4.77E-02	2.86E-09	0.43	0.000015	0.007	0.13	1	3.615E-12	1.265E-11	1.90E-13	1.085E-11	1.41E-12	1	5.08E-10	1.78E-09	4.13E-09	1.52E-09	2.18E-07	1.60E-12	2.22E-07
Chloroethane	1.20E-01	7.20E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.28E-09	4.47E-09	4.47E-10	3.89E-09	9.58E-09	NA	1.00E-08
Chloroform	NA	NA	0.66	0.0000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	NA	0.035	NA	0.1	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1,1-	NA	NA	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	1.18E-07	4.13E-07	8.99E-08	3.54E-07	3.54E-06	1.58E-10	3.63E-06
Tetrachloroethene	1.11E+01	6.66E-07	4.6	0.000001	0.1	0.051	1	8.415E-10	2.945E-09	2.95E-11	2.524E-09	1.29E-10	1	5.08E-10	1.78E-09	2.54E-09	1.52E-09	7.61E-09	NA	1.02E-08
Trans-1,2-Dichloroethene	4.77E-02	2.86E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	NA	5.2	NA	0.9	NA	1	4.842E-12	1.695E-11	2.88E-14	1.453E-11	1.60E-13	1	6.80E-10	2.38E-09	1.32E-08	2.04E-09	1.02E-07	1.89E-13	1.15E-07
Vinyl chloride	6.39E-02	3.83E-09	0.18	0.0000017	0.02	0.011	1	3.615E-12	1.265E-11	1.11E-13	1.085E-11	1.52E-11	1	5.08E-10	1.78E-09	1.79E-08	1.52E-09	5.08E-07	1.53E-11	5.25E-07
Total	4.77E-02	2.86E-09	0.1	0.00000088	0.003	1.4				2.98E-11		1.45E-10				1.28E-07	4.39E-06		1.75E-10	4.52E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-20
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 50 Tufts St.

Construction Worker at 50 futils St.																	
	Henry's Law Constant at Avg GW Temp (conc/conc) H ¹ 's	Defl Vadose Zone (Layer A + Layer B)	Defl Total (Layer A + Layer B + Layer C)	Deflcrack (Layer A)	Exponent of Peclet Number	Organic Carbon- Water Partition Coefficient Koc	Volatilization from Subsurface Soil to Excavation Air VF	Volatilization from Subsurface Soil to Trench Air VF	Volatilization from Soil Gas to Excavation Air Alpha	Volatilization from Soil Gas to Trench Air Alpha	Volatilization from Groundwater to Excavation Air VF	Volatilization from Groundwater to Trench Air VF					
Compound	(conc/conc)	(cm2/sec)	(cm2/sec)	(cm2/sec)		(cm3/g)	(mg/m3) / (mg/kg)	(mg/m3) / (mg/kg)	(mg/m3 excav) / (mg/m3 SG)	(mg/m3 trench) / (mg/m3 SG)	(mg/m3) / (mg/L)	(mg/m3) / (mg/L)					
Carbon tetrachloride	5.88E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	152	1.53E-03	6.95E-03	9.35E-05	6.13E-06	3.91E-02	2.56E-03					
Chloroethane	4.77E-01	5.35E-02	3.80E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.64E-02	3.25E-04	2.13E-05	1.10E-01	7.21E-03					
Chloroform	8.04E-02	2.05E-02	1.46E-02	2.05E-02	1.20E+78	52.5	1.11E-03	5.06E-03	1.25E-04	8.17E-06	7.13E-03	4.67E-04					
Dichloroethane, 1,1-	1.24E-01	1.46E-02	1.04E-02	1.46E-02	2.74E+109	53.4	1.15E-03	5.25E-03	8.89E-05	5.83E-06	7.86E-03	5.15E-04					
Dichloroethene, cis-1,2-	8.79E-02	1.45E-02	1.03E-02	1.45E-02	2.13E+110	35.5	1.17E-03	5.34E-03	8.82E-05	5.78E-06	5.52E-03	3.62E-04					
Dichloroethene, 1,1-	6.34E-01	1.78E-02	1.26E-02	1.78E-02	1.68E+90	65	2.51E-03	1.14E-02	1.08E-04	7.07E-06	4.86E-02	3.18E-03					
Tetrachloroethene	3.24E-01	1.42E-02	1.01E-02	1.42E-02	6.04E+112	265	8.42E-04	3.83E-03	8.63E-05	5.65E-06	1.99E-02	1.30E-03					
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	9.91E-03	1.40E-02	7.16E+114	38	1.71E-03	7.75E-03	8.48E-05	5.55E-06	1.28E-02	8.42E-04					
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	135	1.29E-03	5.85E-03	9.35E-05	6.13E-06	2.43E-02	1.59E-03					
Trichloroethene	1.97E-01	1.56E-02	1.11E-02	1.56E-02	6.13E+102	94.3	1.14E-03	5.18E-03	9.47E-05	6.20E-06	1.33E-02	8.70E-04					
Vinyl chloride	7.65E-01	2.09E-02	1.49E-02	2.09E-02	4.04E+76	18.6	4.71E-03	2.14E-02	1.27E-04	8.32E-06	6.91E-02	4.52E-03					

Table A-21
Site-specific Parameters for Volatilization Calculations
50 Tuttle Street, Somerville MA
UniFirst
Construction Worker at 50 Tuttle St.

Symbol	(units)	Parameter	Value	Comment																																																		
L_{crack}	(cm)	Thickness of foundation	15.0																																																			
f_{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02																																																			
L_f	(15 or 200 cm)	Depth below grade to bottom of enclosed space floor	15	Input either 15 or 200																																																		
L_{wt}	(cm)	Depth below grade to water table	462.0768	15.16 Ft.																																																		
T_s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)																																																		
L_r	(cm)	Source- building separation	447.0768																																																			
L_b	(cm)	Length of building	961	DEP Default																																																		
W_b	(cm)	Width of building	961	DEP Default																																																		
H_b	(cm)	Height of building	488	DEP Default																																																		
X_{crack}	(cm)	Floor- wall seam perimeter	3844.00																																																			
ER	(1/hr)	Air exchange rate	0.45	DEP Default																																																		
$Q_{building}$	(cm³/s)	Bldg. ventilation rate	56334.781																																																			
A_g	(cm²)	Area of enclosed space below grade	923521																																																			
η	(unitless)	Crack- to-total area ratio	0.000416233																																																			
Z_{crack}	(cm)	Crack depth below grade	15.0																																																			
μ_{TS}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414																																																			
L_p	(cm)	Diffusion path length	447.0768																																																			
L_p	(cm)	Convection path length	15																																																			
r_{crack}	(cm)	Crack radius	0.10	DEP Default																																																		
ΔP	g/cm-s²	Pressure differential between soil surface and enclosed space	40.00	DEP Default																																																		
O_{soil}	(cm³/s)	Average vapor flow rate into bldg.	9.454788E+01																																																			
A_{crack}	(cm²)	Area of crack	384.4																																																			
R	(cal/mol-K)	Gas constant	1.9872																																																			
R	(atm-m³/mol-K)	Universal gas constant	0.0008205																																																			
$R2$	(mmHg-cm³/mol-K)	Universal gas constant	62361																																																			
W_{SA}	(cm)	Width of soil source to ambient air	1524	50 Ft.																																																		
t_{SA}	(s)	Averaging time for volatilization from soil to ambient air	15768000	0.5 y																																																		
U	(cm/s)	Wind speed	225																																																			
D	(cm)	Mixing height	182.88	6 Ft.																																																		
Z_s	(cm)	Depth to soil source	462.0768	15.16 Ft.																																																		
Z_{SA}	(cm)	Depth to soil gas source	462.0768	15.16 Ft.																																																		
W_E	(cm)	Width of excavation	1524	50 Ft.																																																		
L_E	(cm)	Length of excavation	762	25 Ft.																																																		
H_E	(cm)	Height of excavation	457.2	15 Ft.																																																		
W_{Ec}	(cm)	Width of excavation that is contaminated	1524	50 Ft.																																																		
L_{Ec}	(cm)	Length of excavation that is contaminated	762	25 Ft.																																																		
H_{Ec}	(cm)	Height of excavation that is contaminated	457.2	15 Ft.																																																		
WT	(cm)	Width of trench	457.2	15 Ft.																																																		
LT	(cm)	Length of trench	121.92	4 Ft.																																																		
HT	(cm)	Height of trench	182.88	6 Ft.																																																		
W_{Tc}	(cm)	Width of trench that is contaminated	457.2	15 Ft.																																																		
L_{Tc}	(cm)	Length of trench that is contaminated	121.92	4 Ft.																																																		
H_{Tc}	(cm)	Height of trench that is contaminated	182.88	6 Ft.																																																		
t_{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y																																																		
t_{ST}	(s)	Averaging time for volatilization from soil to trench	31536000	1 y																																																		
F_L	(unitless)	Fraction of wind speed that occurs in excavation	0.5																																																			
F_T	(unitless)	Fraction of wind speed that occurs in trench	0.1																																																			
d	(cm)	Lower depth of surface soil source	462.0768	15.16 Ft.																																																		
<table><tr><th colspan="2">Vadose Zone</th><th>Vadose Zone Layer A</th><th>Vadose Zone Layer B</th><th>Capillary Zone</th></tr><tr><td>ρ_b</td><td>(g/cm³)</td><td>1.5</td><td>1.5</td><td>1.5</td></tr><tr><td>n</td><td>(unitless)</td><td>0.43</td><td>0.43</td><td>0.43</td></tr><tr><td>θ_w</td><td>(cm³/cm³)</td><td>0.06</td><td>0.06</td><td>0.253258113</td></tr><tr><td>θ_a</td><td>(cm³/cm³)</td><td>0.37</td><td>0.37</td><td>0.176741887</td></tr><tr><td>h</td><td>(cm)</td><td>15</td><td>415.0313455</td><td>17.04545455</td></tr><tr><td>S_w</td><td>(cm³/cm³)</td><td></td><td></td><td>0.018567839</td></tr><tr><td>k_i</td><td>(cm²)</td><td></td><td></td><td>9.92425E-08</td></tr><tr><td>k_{ag}</td><td>(cm²)</td><td></td><td></td><td>0.986637033</td></tr><tr><td>k_e</td><td>(cm²)</td><td></td><td></td><td>9.79163E-08</td></tr></table>					Vadose Zone		Vadose Zone Layer A	Vadose Zone Layer B	Capillary Zone	ρ_b	(g/cm³)	1.5	1.5	1.5	n	(unitless)	0.43	0.43	0.43	θ_w	(cm³/cm³)	0.06	0.06	0.253258113	θ_a	(cm³/cm³)	0.37	0.37	0.176741887	h	(cm)	15	415.0313455	17.04545455	S_w	(cm³/cm³)			0.018567839	k_i	(cm²)			9.92425E-08	k_{ag}	(cm²)			0.986637033	k_e	(cm²)			9.79163E-08
Vadose Zone		Vadose Zone Layer A	Vadose Zone Layer B	Capillary Zone																																																		
ρ_b	(g/cm³)	1.5	1.5	1.5																																																		
n	(unitless)	0.43	0.43	0.43																																																		
θ_w	(cm³/cm³)	0.06	0.06	0.253258113																																																		
θ_a	(cm³/cm³)	0.37	0.37	0.176741887																																																		
h	(cm)	15	415.0313455	17.04545455																																																		
S_w	(cm³/cm³)			0.018567839																																																		
k_i	(cm²)			9.92425E-08																																																		
k_{ag}	(cm²)			0.986637033																																																		
k_e	(cm²)			9.79163E-08																																																		

Note
Values Assume all sources are 1 inch below excavation depth

Select soil type in vadose zone and capillary zone:

Vadose zone adjacent to building Sand

Capillary zone Sand

Key:

Type in Site-specific values here
Calculated values
Constants
Default parameter values from DEP

Table A-22
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
Unifirst
Construction Worker at 50 Tufts St.
Excavation Air
Volatilization from Soil Gas

Receptor:	Construction Worker	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{soil\ gas} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil Gas mg/m3	Alpha Volatilization from Soil Gas to Excavation Air (mg/m3 excav) / (mg/m3 SG)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	NA	9.35E-05	1	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	3.25E-04	1	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	1.25E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	8.89E-05	1	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	8.82E-05	1	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	1.08E-04	1	NA	0.2	NA	1	NA	NA	1	NA	NA	NA	NA
Tetrachloroethene	NA	8.63E-05	1	NA	4.6	0.00001	1	NA	NA	1	NA	NA	NA	NA
Trans-1,2-Dichloroethene	NA	8.48E-05	1	NA	0.7	NA	NC	NA	NA	1	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	9.35E-05	1	NA	5.2	NA	NC	NA	NA	1	NA	NA	NA	NA
Trichloroethene	NA	9.47E-05	1	NA	0.18	0.0000017	1	NA	NA	1	NA	NA	NA	NA
Vinyl chloride	NA	1.27E-04	1	NA	0.1	0.0000088	1	NA	NA	1	NA	NA	NA	NA
Total									NC			NC	no data	no data

NA - Not available
NC - Not calculated
ND - Not detected

Table A-23
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 50 Tufts St.
Excavation Air
Volatilization from Subsurface Soil

Receptor:	Construction Worker
Medium of Origin:	Subsurface Soil
Exposure Medium:	Excavation Air
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	VF	Volatilization from Subsurface Soil to Excavation Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC	RfC	URF	RAFic	ADE-c	Riskinh	RAFinc	ADE-nc	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.0477	1.53E-03		1	7.30E-05	0.43	0.000015	1	1.24E-07	1.86E-09	1	8.66E-06	2.01E-05	1.86E-09	2.01E-05
Chloroethane	0.12	5.80E-03		1	6.96E-04	10	NA	NC	NA	NA	1	8.26E-05	8.26E-06	NA	8.26E-06
Chloroform	NA	1.11E-03		1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	1.15E-03		1	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	1.17E-03		1	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1,1-	NA	2.51E-03		1	NA	0.2	NA	1	NA	NA	1	1.11E-03	2.41E-04	1.59E-07	2.41E-04
Tetrachloroethene	11.10188	8.42E-04		1	9.35E-03	4.6	0.00001	1	1.59E-05	1.59E-07	1	9.66E-06	1.38E-05	NA	1.38E-05
Trans-1,2-Dichloroethene	0.0477	1.71E-03		1	8.14E-05	0.7	NA	NC	NA	NA	1	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	1.29E-03		1	NA	5.2	NA	NC	NA	NA	1	8.64E-06	4.80E-05	2.10E-10	4.80E-05
Trichloroethene	0.06388	1.14E-03		1	7.28E-05	0.18	0.0000017	1	1.23E-07	2.10E-10	1	2.67E-05	2.67E-04	3.36E-09	2.67E-04
Vinyl chloride	0.0477	4.71E-03		1	2.25E-04	0.1	0.0000088	1	3.81E-07	3.36E-09	1	2.67E-05	2.67E-04	1.64E-07	5.98E-04
Total										1.64E-07			5.98E-04		

NA - Not available
NC - Not calculated
ND - Not detected

Table A-24
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 50 Tufts St.
Excavation Air
Volatilization from Groundwater

Receptor:	Construction Worker
Medium of Origin:	Groundwater
Exposure Medium:	Excavation Air
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha_{pha})}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	VF	Volatilization from Groundwater to Excavation Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	1.36E-01	3.91E-02		1	5.32E-03	0.43	0.000015	1	9.03E-06	1.35E-07	1	6.32E-04	1.47E-03	1.35E-07	1.47E-03
Chloroethane	0.2505	1.10E-01		1	2.76E-02	10	NA	NC	NA	NA	1	3.27E-03	3.27E-04	NA	3.27E-04
Chloroform	0.1258	7.13E-03		1	8.96E-04	0.66	0.000023	1	1.52E-06	3.50E-08	1	1.06E-04	1.61E-04	3.50E-08	1.61E-04
Dichloroethane, 1,1-	0.15495	7.86E-03		1	1.22E-03	5	NA	NC	NA	NA	1	1.45E-04	2.89E-05	NA	2.89E-05
Dichloroethene, cis-1,2-	0.2224	5.52E-03		1	1.23E-03	0.035	NA	NC	NA	NA	1	1.46E-04	4.16E-03	NA	4.16E-03
Dichloroethene, 1,1-	3.076666667	4.86E-02		1	1.50E-01	0.2	NA	1	NA	NA	1	1.78E-02	8.88E-02	NA	8.88E-02
Tetrachloroethene	62.25	1.99E-02		1	1.24E+00	4.6	0.00001	1	2.10E-03	2.10E-05	1	1.47E-01	3.19E-02	2.10E-05	3.19E-02
Trans-1,2-Dichloroethene	0.12525	1.28E-02		1	1.61E-03	0.7	NA	NC	NA	NA	1	1.91E-04	2.73E-04	NA	2.73E-04
Trichloroethane, 1,1,1-	143	2.43E-02		1	3.47E+00	5.2	NA	NC	NA	NA	1	4.12E-01	7.93E-02	NA	7.93E-02
Trichloroethene	111.5	1.33E-02		1	1.48E+00	0.18	0.0000017	1	2.51E-03	4.27E-06	1	1.76E-01	9.76E-01	4.27E-06	9.76E-01
Vinyl chloride	0.1256	6.91E-02		1	8.67E-03	0.1	0.0000088	1	1.47E-05	1.29E-07	1	1.03E-03	1.03E-02	1.29E-07	1.03E-02
Total										2.56E-05			1.19E+00	2.56E-05	1.19E+00

NA - Not available
NC - Not calculated
ND - Not detected

Table A-25
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 50 Tufts St.
Excavation Air

Receptor:	Construction Worker	▼
Medium of Origin:	Excavation Air	▼
Exposure Medium:	Excavation	▼
Exposure Area:	0-15 feet	▼
Depth:	Subchronic	▼
Duration:		

All 3 media

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	2.70E-03	0.43	0.000015	1	4.57E-06	6.86E-08	1	3.20E-04	7.45E-04	6.86E-08	7.45E-04
Chloroethane	1.41E-02	10	NA	NC	NA	NA	1	1.68E-03	1.68E-04	NA	1.68E-04
Chloroform	8.96E-04	0.66	0.000023	1	1.52E-06	3.50E-08	1	1.06E-04	1.61E-04	3.50E-08	1.61E-04
Dichloroethane, 1,1-	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	0.2	NA	1	NA	NA	1	NA	NA	NA	NA
Tetrachloroethene	6.24E-01	4.6	0.00001	1	1.06E-03	1.06E-05	1	7.40E-02	1.61E-02	1.06E-05	1.61E-02
Trans-1,2-Dichloroethene	8.45E-04	0.7	NA	NC	NA	NA	1	1.00E-04	1.43E-04	NA	1.43E-04
Trichloroethane, 1,1,1-	3.47E+00	5.2	NA	NC	NA	NA	1	4.12E-01	7.93E-02	NA	7.93E-02
Trichloroethene	7.40E-01	0.18	0.000017	1	1.26E-03	2.13E-06	1	8.79E-02	4.88E-01	2.13E-06	4.88E-01
Vinyl chloride	4.45E-03	0.1	0.0000088	1	7.55E-06	6.64E-08	1	5.28E-04	5.28E-03	6.64E-08	5.28E-03
Total						1.29E-05			5.90E-01	1.29E-05	5.90E-01

NA - Not available
NC - Not calculated
ND - Not detected

Table A-26
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
Unifirst
Utility Worker at 50 Tufts St.
Soil - Dermal contact & Incidental Ingestion
0-6 feet

Receptor:	Utility Worker
Medium:	Surface Soil
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IR _{soil}	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.29	
EF	Soil Exposure Frequency	d/y	1	
EP	Soil Exposure Period - Cancer	y	5	
EP	Soil Exposure Period - Non-Cancer	y	5	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	1825	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total							
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling	RAFdsnc	ADDder-c mg/kg-d	Riskder	RAFdsnc mg/kg-d	Hlder	Risk (Soil)	HI (Soil)	
Carbon tetrachloride	0.0477	0.007	0.13	1	1.61E-11	2.09E-12	1	2.25E-10	3.22E-08	0.1	1.62E-11	2.11E-12	0.1	2.27E-10	3.24E-08	6.46E-08	
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	5.67E-10	1.42E-09	NC	NA	NA	0.1	5.71E-10	1.43E-09	NA	
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	0.1	NA	NA	NA	
Dichloroethane, 1,1-	NA	1	NA	NC	NA	NA	1.3	NA	NA	NC	NA	NA	0.13	NA	NA	NA	
Dichloroethene, cis-1,2-	NA	0.1	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	
Dichloroethene, 1,1-	NA	0.05	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	
Tetrachloroethene	11.10188	0.1	0.051	1	3.75E-09	1.91E-10	1	5.24E-08	5.24E-07	0.1	3.77E-09	1.92E-10	0.1	5.28E-08	5.28E-07	3.83E-10	
Trans-1,2-Dichloroethene	0.0477	0.2	NA	NC	NA	NA	1	2.25E-10	1.13E-09	NC	NA	NA	0.1	2.27E-10	1.13E-09	NA	
Trichloroethane, 1,1,1-	NA	0.9	NA	NC	NA	NA	1	NA	NA	NC	NA	NA	0.1	NA	NA	NA	
Trichloroethene	0.06388	0.02	0.011	1	2.16E-11	2.37E-13	1	3.02E-10	1.51E-08	0.1	2.17E-11	2.39E-13	0.1	3.04E-10	1.52E-08	4.76E-13	
Vinyl chloride	0.0477	0.003	1.4	1.53	2.46E-11	3.45E-11	1	2.25E-10	7.51E-08	0.16	2.59E-11	3.63E-11	0.1	2.27E-10	7.56E-08	7.08E-11	
Total						2.28E-10			6.49E-07			2.31E-10			6.54E-07	4.59E-10	1.30E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-27
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Utility Worker at 50 Tufts St
Ambient Air
Trench
0-6 feet

Receptor:	Utility Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	1	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	5	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	1825	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil Trench 0-6 feet (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inh mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	Hi (Particulates in Air) YC
Carbon tetrachloride	4.77E-02	2.86E-09	0.43	0.000015	0.007	0.13	1	1.39E-13	4.867E-13	7.33E-15	4.172E-13	8.34E-10	6.15E-14	8.50E-10
Chloroethane	1.20E-01	7.20E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	3.67E-11	NA	3.84E-11
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	NA	5	NA	1	NA	NC	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	NA	0.035	NA	0.1	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1,1-	NA	NA	0.2	NA	0.05	0.051	1	4.53E-10	1.59E-09	3.45E-10	1.36E-09	1.36E-08	6.08E-12	1.39E-08
Tetrachloroethene	1.11E+01	6.66E-07	4.6	0.00001	0.1	NA	1	1.95E-12	6.81E-12	9.73E-12	5.84E-12	2.92E-11	NA	3.89E-11
Trans-1,2-Dichloroethene	4.77E-02	2.86E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	NA	5.2	0.0000017	0.9	0.011	1	2.61E-12	9.12E-12	5.07E-11	7.82E-12	3.91E-10	7.22E-15	4.42E-10
Trichloroethene	6.39E-02	3.83E-09	0.18	0.00000088	0.02	1.4	1	1.95E-12	6.81E-12	6.81E-11	5.84E-12	1.95E-09	5.88E-13	2.01E-09
Vinyl chloride	4.77E-02	2.86E-09	0.1	0.00000088	0.003	1.4	1	1.95E-12	6.81E-12	6.81E-11	5.84E-12	1.95E-09	6.74E-12	1.73E-08
Total														

NA - Not available
NC - Not calculated
ND - Not detected

Table A-28
Exposure and Risk Estimates Associated With Groundwater Contact
50 Tufts Street, Somerville MA
UniFirst
Utility Worker at 50 Tufts St.
Groundwater
Trench
0-6 feet

Receptor:	Utility Worker
Medium:	Groundwater
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRgw	Groundwater Ingestion Rate	L/d	0.01	
SA	Groundwater Dermal Contact Skin Exposed	cm2	817	
EF	Groundwater Exposure Frequency	d/y	1	
EP	Groundwater Exposure Period - Cancer	y	5	
EP	Groundwater Exposure Period - Non-Cancer	y	5	
ATc	Groundwater Averaging Time - Cancer	d	25550	
ATn	Groundwater Averaging Time - Non-Cancer	d	1825	
ET	Groundwater Dermal Contact Exposure Time	hr/d	2	
BW	Body Weight	kg	58	
CF	Conversion Factor	L/cm3	1.00E-03	

$$ADD_{ing} = \frac{C_{gw} \times IR_{gw} \times RAF_{ow} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{gw} \times CF \times SA \times K_p \times ET \times RAF_{dw} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk = ADD_{ing} \times CSF$$

$$Risk = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Groundwater Trench 0-6 feet (mg/L)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact						Total					
				RAFowc	ADDing-c mg/kg-d	Risking	RAFownc	ADDing-nc mg/kg-d	Hling	Kp (cm/hr)	RAFdwc	ADDder-c mg/kg-d		Riskder	RAFdwc	ADDder-nc mg/kg-d	Hlder	Risk(GW)
Carbon tetrachloride	0.1362	0.007	0.13	1	4.60E-09	5.97E-10	1	6.43E-08	9.19E-06	0.0160472	1	1.20E-08	1.57E-09	1	1.69E-07	2.41E-05	2.16E-09	3.33E-05
Chloroethane	0.2505	0.4	NA	NC	NA	NA	1	1.18E-07	2.96E-07	0.0060602	NC	NA	NA	1	1.17E-07	2.93E-07	NA	5.89E-07
Chloroform	0.1258	0.01	NA	NC	NA	NA	1	5.94E-08	5.94E-06	0.0068	NC	NA	NA	1	6.60E-08	6.60E-06	NA	1.25E-05
Dichloroethane,1,1-	0.15495	1	NA	NC	NA	NA	1.3	9.52E-08	9.52E-08	0.0067143	NC	NA	NA	1	8.03E-08	8.03E-08	NA	1.75E-07
Dichloroethene, cis-1,2-	0.2224	0.1	NA	NC	NA	NA	1	1.05E-07	1.05E-06	0.0065826	NC	NA	NA	1	1.13E-07	1.13E-06	NA	2.18E-06
Dichloroethene,1,1-	3.076666667	0.05	NA	NC	NA	NA	1	1.45E-06	2.91E-05	0.0043013	NC	NA	NA	1	1.02E-06	2.04E-05	NA	4.95E-05
Tetrachloroethene	62.25	0.1	0.051	1	2.10E-06	1.07E-07	1	2.94E-05	2.94E-04	0.0326889	1	1.12E-05	5.72E-07	1	1.57E-04	1.57E-03	6.79E-07	1.86E-03
Trans-1,2-Dichloroethene	0.12525	0.2	NA	NC	NA	NA	1	5.92E-08	2.96E-07	0.0108693	NC	NA	NA	1	1.05E-07	5.25E-07	NA	8.21E-07
Trichloroethane,1,1,1-	143	0.9	NA	NC	NA	NA	1	6.75E-05	7.51E-05	0.0125487	NC	NA	NA	1	1.39E-04	1.54E-04	NA	2.29E-04
Trichloroethene	111.5	0.02	0.011	1	3.76E-06	4.14E-08	1	5.27E-05	2.63E-03	0.0115771	1	7.12E-06	7.83E-08	1	9.96E-05	4.98E-03	1.20E-07	7.62E-03
Vinyl chloride	0.1256	0.003	1.4	1.53	6.48E-09	9.08E-09	1	5.93E-08	1.98E-05	0.008249	1	5.71E-09	8.00E-09	1	8.00E-08	2.67E-05	1.71E-08	4.64E-05
Total						1.58E-07			3.07E-03				6.60E-07			6.79E-03	8.18E-07	9.85E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-29
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Utility Worker at 50 Tufts St.

Compound	Henry's Law Constant at Avg GW Temp (conc/conc) H'_{Ts}	Defl Vadose Zone (Layer A + Layer B)	Defl Total (Layer A + Layer B + Layer C)	Deflcrack (Layer A)	Exponent of Pecllet Number	Organic Carbon- Water Partition Coefficient Koc	Volatilization from Subsurface Soil to Excavation Air VF	Volatilization from Subsurface Soil to Trench Air VF	Volatilization from Soil Gas to Excavation Air Alpha	Volatilization from Soil Gas to Trench Air Alpha	Volatilization from Groundwater to Excavation Air VF	Volatilization from Groundwater to Trench Air VF
Compound	(conc/conc)	(cm2/sec)	(cm2/sec)	(cm2/sec)		(cm3/g)	(mg/m3) / (mg/kg)	(mg/m3) / (mg/kg)	(mg/m3 excav) / (mg/m3 SG)	(mg/m3 trench) / (mg/m3 SG)	(mg/m3) / (mg/L)	(mg/m3) / (mg/L)
Carbon tetrachloride	5.88E-01	1.54E-02	7.49E-03	1.54E-02	1.28E+104	152	1.53E-03	5.88E-02	-1.69E-06	3.51E-04	-4.84E-04	1.00E-01
Chloroethane	4.77E-01	5.35E-02	2.60E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.23E-01	-5.88E-06	1.22E-03	-1.36E-03	2.82E-01
Chloroform	8.04E-02	2.05E-02	1.00E-02	2.05E-02	1.20E+78	52.5	1.11E-03	4.28E-02	-2.26E-06	4.67E-04	-8.84E-05	1.83E-02
Dichloroethane, 1,1-	1.24E-01	1.46E-02	7.13E-03	1.46E-02	2.74E+109	53.4	1.15E-03	4.43E-02	-1.61E-06	3.33E-04	-9.75E-05	2.02E-02
Dichloroethene, cis-1,2-	8.79E-02	1.45E-02	7.08E-03	1.45E-02	2.13E+110	35.5	1.17E-03	4.51E-02	-1.60E-06	3.31E-04	-6.85E-05	1.42E-02
Dichloroethene, 1,1-	6.34E-01	1.78E-02	8.64E-03	1.78E-02	1.68E+90	65	2.51E-03	9.62E-02	-1.95E-06	4.04E-04	-6.03E-04	1.25E-01
Tetrachloroethene	3.24E-01	1.42E-02	6.91E-03	1.42E-02	6.04E+112	265	8.42E-04	3.23E-02	-1.56E-06	3.24E-04	-2.47E-04	5.11E-02
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	6.79E-03	1.40E-02	7.16E+114	38	1.71E-03	6.55E-02	-1.53E-06	3.18E-04	-1.59E-04	3.30E-02
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	7.49E-03	1.54E-02	1.28E+104	135	1.29E-03	4.95E-02	-1.69E-06	3.51E-04	-3.01E-04	6.24E-02
Trichloroethene	1.97E-01	1.56E-02	7.59E-03	1.56E-02	6.13E+102	94.3	1.14E-03	4.38E-02	-1.71E-06	3.55E-04	-1.65E-04	3.41E-02
Vinyl chloride	7.65E-01	2.09E-02	1.02E-02	2.09E-02	4.04E+76	18.6	4.71E-03	1.81E-01	-2.30E-06	4.76E-04	-8.56E-04	1.77E-01

Table A-30
Site-specific Parameters for Volatilization Calculations
50 Tufts Street, Somerville MA
UnFirst
Utility Worker at 50 Tufts St.

Symbol	(units)	Parameter	Value	Comment
L_{Crack}	(cm)	Thickness of foundation	15.0	
f_{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02	
L_f	(15 or 200 cm)	Depth below grade to bottom of enclosed space floor	15	Input either 15 or 200
L_{wrt}	(cm)	Depth below grade to water table	187.7568	6.16 Ft
T_s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)
L_r	(cm)	Source- building separation	172.7568	
L_g	(cm)	Length of building	961	DEP Default
W_g	(cm)	Width of building	961	DEP Default
H_g	(cm)	Height of building	488	DEP Default
X_{Crack}	(cm)	Floor - wall seam perimeter	3844.00	
ER	(1/hr)	Air exchange rate	0.45	DEP Default
$Q_{building}$	(cm³/s)	Bldg. ventilation rate	56334.781	
A_g	(cm²)	Area of enclosed space below grade	923521	
η	(unitless)	Crack- to-total area ratio	0.000416233	
Z_{Crack}	(cm)	Crack depth below grade	15.0	
μ_{TS}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414	
L_d	(cm)	Diffusion path length	172.7568	
L_p	(cm)	Convection path length	15	
r_{Crack}	(cm)	Crack radius	0.10	DEP Default
ΔP	g/cm-s2	Pressure differential between soil surface and enclosed space	40.00	DEP Default
Q_{soil}	(cm³/s)	Average vapor flow rate into bldg.	9.454788E+01	
A_{Crack}	(cm²)	Area of crack	384.4	
R	(cal/mol-K)	Gas constant	1.9872	
R	(atm-m3/mol-K)	Universal gas constant	0.0008205	
R2	(mmHg-cm3/mol-K)	Universal gas constant	62361	
W_{SA}	(cm)	Width of soil source to ambient air	1524	50 Ft
t_{SA}	(s)	Averaging time for volatilization from soil to ambient air	441504	0.014 y
U	(cm/s)	Wind speed	225	
D	(cm)	Mixing height	182.88	6 Ft
Z_s	(cm)	Depth to soil source	187.7568	6.16 Ft
Z_{eg}	(cm)	Depth to soil gas source	187.7568	6.16 Ft
W_E	(cm)	Width of excavation	1524	50 Ft
L_E	(cm)	Length of excavation	762	25 Ft
H_E	(cm)	Height of excavation	457.2	15 Ft
W_{Ec}	(cm)	Width of excavation that is contaminated	1524	50 Ft
L_{Ec}	(cm)	Length of excavation that is contaminated	762	25 Ft
H_{Ec}	(cm)	Height of excavation that is contaminated	457.2	15 Ft
WT	(cm)	Width of trench	457.2	15 Ft
LT	(cm)	Length of trench	121.92	4 Ft
HT	(cm)	Height of trench	182.88	6 Ft
WTC	(cm)	Width of trench that is contaminated	457.2	15 Ft
LTC	(cm)	Length of trench that is contaminated	121.92	4 Ft
HTC	(cm)	Height of trench that is contaminated	182.88	6 Ft
t_{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y
t_{ST}	(s)	Averaging time for volatilization from soil to trench	441504	0.014 y
F_E	(unitless)	Fraction of wind speed that occurs in excavation	0.5	
F_T	(unitless)	Fraction of wind speed that occurs in trench	0.1	
d	(cm)	Lower depth of surface soil source	462.0768	15.16 Ft
Vadose Zone				
Layer A				
P_b	(g/cm³)	Vadose zone soil dry bulk density	1.5	1.5
n	(unitless)	Vadose zone soil total porosity	0.43	0.43
θ_w	(cm³/cm³)	Vadose zone soil water-filled porosity	0.06	0.06
θ_a	(cm³/cm³)	Vadose zone soil air-filled porosity	0.37	0.37
h	(cm)	Thickness of soil layer	15	140.7113455
S_{se}	(cm³/cm³)	Vadose zone effective total fluid saturation		17.04545455
k_i	(cm²)	Vadose zone soil intrinsic permeability		0.018587639
k_{ra}	(cm²)	Vadose zone soil relative air permeability		9.92425E-09
k_v	(cm²)	Vadose zone soil effective vapor permeability		0.986637033
				9.79163E-08

Select soil type in vadose zone and capillary zone:
Vadose zone adjacent to building Sand
Capillary zone Sand

Key:
Type in Site-specific values here
Calculated values
Constants
Default parameter values from DEP

Table A-31
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker at 50 Tufts St.
Trench Air
Volatilization from Soil Gas

Receptor:	Utility Worker
Medium of Origin:	Soil Gas
Exposure Medium:	Trench Air
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil Gas mg/m3	Alpha Volatilization from Soil Gas to Trench Air (mg/m3 trench) / (mg/m3 SG)	Source Dilution Factor	EPC Trench Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	NA	3.51E-04	1	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	1.22E-03	1	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	4.67E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	3.33E-04	1	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	3.31E-04	1	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	4.04E-04	1	NA	0.2	NA	1	NA	NA	1	NA	NA	NA	NA
Tetrachloroethene	NA	3.24E-04	1	NA	4.6	0.00001	1	NA	NA	1	NA	NA	NA	NA
Trans-1,2-Dichloroethene	NA	3.18E-04	1	NA	0.7	NA	NC	NA	NA	1	NA	NA	NA	NA
Trichloroethane, 1,1,1-	NA	3.51E-04	1	NA	5.2	NA	NC	NA	NA	1	NA	NA	NA	NA
Trichloroethene	NA	3.55E-04	1	NA	0.18	0.0000017	1	NA	NA	1	NA	NA	NA	NA
Vinyl chloride	NA	4.76E-04	1	NA	0.1	0.0000088	1	NA	NA	1	NA	NA	NA	NA
Total									NC			NC	no data	no data

NA - Not available
NC - Not calculated
ND - Not detected

Table A-32
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker at 50 Tufts St.
Trench Air
Volatilization from Subsurface Soil

Receptor:	Utility Worker	▼
Medium of Origin:	Subsurface Soil	▼
Exposure Medium:	Trench Air	▼
Exposure Area:	Trench	▼
Depth:	0-6 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{soil} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Subsurface Soil mg/kg	VF Volatilization from Subsurface Soil to Trench Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC Trench Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	RiskInh	RAFiC	ADE-nc mg/m3	HIinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.0477	5.88E-02	1	2.80E-03	0.43	0.000015	1	1.83E-07	2.74E-09	1	2.56E-06	5.95E-06	2.74E-09	5.95E-06
Chloroethane	0.12	2.23E-01	1	2.67E-02	10	NA	NC	NA	NA	1	2.44E-05	2.44E-06	NA	2.44E-06
Chloroform	NA	4.28E-02	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	4.43E-02	1	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	4.51E-02	1	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	9.62E-02	1	NA	0.2	NA	1	NA	NA	1	NA	NA	NA	NA
Tetrachloroethene	11.10188	3.23E-02	1	3.59E-01	4.6	0.00001	1	2.34E-05	2.34E-07	1	3.28E-04	7.13E-05	2.34E-07	7.13E-05
Trans-1,2-Dichloroethene	0.0477	6.55E-02	1	3.13E-03	0.7	NA	NC	NA	NA	1	2.85E-06	4.08E-06	NA	4.08E-06
Trichloroethane, 1,1,1-	NA	4.95E-02	1	NA	5.2	NA	NC	NA	NA	1	NA	NA	NA	NA
Trichloroethene	0.06388	4.38E-02	1	2.80E-03	0.18	0.0000017	1	1.82E-07	3.10E-10	1	2.55E-06	1.42E-05	3.10E-10	1.42E-05
Vinyl chloride	0.0477	1.81E-01	1	8.64E-03	0.1	0.0000088	1	5.63E-07	4.96E-09	1	7.89E-06	7.89E-05	4.96E-09	7.89E-05
Total									2.42E-07			1.77E-04	2.42E-07	1.77E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-33
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker at 50 Tufts St.
Trench Air
Volatilization from Groundwater

Receptor:	Utility Worker
Medium of Origin:	Groundwater
Exposure Medium:	Trench Air
Exposure Area:	Trench
Depth:	0-15 feet
Duration:	Subchronic

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Groundwater (mg/L)	VF Volatilization from Groundwater to Trench Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC Trench Air (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	1.36E-01	1.00E-01	1	1.37E-02	0.43	0.000015	1	8.92E-07	1.34E-08	1	1.25E-05	2.90E-05	1.34E-08	2.90E-05
Chloroethane	0.2505	2.82E-01	1	7.07E-02	10	NA	NC	NA	NA	1	6.46E-05	6.46E-06	NA	6.46E-06
Chloroform	0.1258	1.83E-02	1	2.30E-03	0.66	0.000023	1	1.50E-07	3.46E-09	1	2.10E-06	3.19E-06	3.46E-09	3.19E-06
Dichloroethane, 1,1-	0.15495	2.02E-02	1	3.13E-03	5	NA	NC	NA	NA	1	2.86E-06	5.72E-07	NA	5.72E-07
Dichloroethene, cis-1,2-	0.2224	1.42E-02	1	3.16E-03	0.035	NA	NC	NA	NA	1	2.88E-06	8.24E-05	NA	8.24E-05
Dichloroethene, 1,1-	3.076666667	1.25E-01	1	3.84E-01	0.2	NA	1	NA	NA	1	3.51E-04	1.75E-03	NA	1.75E-03
Tetrachloroethene	62.25	5.11E-02	1	3.18E+00	4.6	0.00001	1	2.07E-04	2.07E-06	1	2.90E-03	6.31E-04	2.07E-06	6.31E-04
Trans-1,2-Dichloroethene	0.12525	3.30E-02	1	4.13E-03	0.7	NA	NC	NA	NA	1	3.78E-06	5.39E-06	NA	5.39E-06
Trichloroethane, 1,1,1-	143	6.24E-02	1	8.92E+00	5.2	NA	NC	NA	NA	1	8.15E-03	1.57E-03	NA	1.57E-03
Trichloroethene	111.5	3.41E-02	1	3.80E+00	0.18	0.0000017	1	2.48E-04	4.22E-07	1	3.47E-03	1.93E-02	4.22E-07	1.93E-02
Vinyl chloride	0.1256	1.77E-01	1	2.23E-02	0.1	0.0000088	1	1.45E-06	1.28E-08	1	2.03E-05	2.03E-04	1.28E-08	2.03E-04
Total									2.52E-06			2.36E-02	2.52E-06	2.36E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-34
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker at 50 Tufts St.
Trench Air

Receptor:	Utility Worker	▼
Medium of Origin:		▼ All 3 media
Exposure Medium:	Trench Air	▼
Exposure Area:	Trench	▼
Depth:	0-6 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Average of 3 media (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	8.24E-03	0.43	0.000015	1	5.37E-07	8.06E-09	1	7.52E-06	1.75E-05	8.06E-09	1.75E-05
Chloroethane	4.87E-02	10	NA	NC	NA	NA	1	4.45E-05	4.45E-06	NA	4.45E-06
Chloroform	2.30E-03	0.66	0.000023	1	1.50E-07	3.46E-09	1	2.10E-06	3.19E-06	3.46E-09	3.19E-06
Dichloroethane, 1,1-	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, cis-1,2-	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, 1,1-	NA	0.2	NA	1	NA	NA	1	NA	NA	NA	NA
Tetrachloroethene	1.77E+00	4.6	0.00001	1	1.15E-04	1.15E-06	1	1.62E-03	3.51E-04	1.15E-06	3.51E-04
Trans-1,2-Dichloroethene	3.63E-03	0.7	NA	NC	NA	NA	1	3.32E-06	4.74E-06	NA	4.74E-06
Trichloroethane, 1,1,1-	8.92E+00	5.2	NA	NC	NA	NA	1	8.15E-03	1.57E-03	NA	1.57E-03
Trichloroethene	1.90E+00	0.18	0.0000017	1	1.24E-04	2.11E-07	1	1.74E-03	9.65E-03	2.11E-07	9.65E-03
Vinyl chloride	1.55E-02	0.1	0.0000088	1	1.01E-06	8.87E-09	1	1.41E-05	1.41E-04	8.87E-09	1.41E-04
Total						1.39E-06			1.17E-02	1.39E-06	1.17E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-35
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Resident at 60 Tufts St.
Soil

Receptor:	Resident
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm2/d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-ci	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPc	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Exposure Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$
$$ADD_{der-nc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$
$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{os} \times EF}{AP}$$
$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{ds} \times EF}{AP}$$
$$HI_{ing} = \frac{ADD_{ing-nc}}{RfD}$$
$$HI_{der} = \frac{ADD_{der-nc}}{RfD}$$
$$HI = HI_{ing} + HI_{der}$$
$$Risk_{ing} = ADD_{ing-c} \times CS$$
$$Risk_{der} = ADD_{der-c} \times CSF$$
$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total							
				RAFosc	Adding-c mg/kg-d	Risking	RAFosc	ADDder-c mg/kg-d	Riskder	RAFdsc	ADDder-nc mg/kg-d	Hlder	Risk (Soil) YC-OC-A	HI (Soil) YC			
Carbon tetrachloride	0.0475	0.0007	0.13	1	1.77E-08	2.30E-09	1	1.15E-07	1.64E-04	0.1	1.84E-08	2.39E-09	0.1	9.77E-08	1.40E-04	4.70E-09	3.04E-04
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	2.90E-07	7.25E-07	NC	NA	NA	0.1	2.47E-07	6.17E-07	NA	1.34E-06
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.0475	0.1	NA	NC	NA	NA	1.3	1.49E-07	1.49E-06	NC	NA	NA	0.13	1.27E-07	1.27E-06	NA	2.76E-06
Dichloroethene, cis-1,2-	0.0475	0.01	NA	1	1.15E-07	NA	1	1.15E-07	1.15E-05	NC	NA	NA	0.1	9.77E-08	9.77E-06	NA	2.13E-05
Dichloroethene, 1,1-	0.0475	0.05	NA	NC	NA	NA	1	1.15E-07	2.30E-06	NC	NA	NA	0.1	9.77E-08	1.95E-06	NA	4.25E-06
Tetrachloroethene	0.178	0.01	0.051	1	6.64E-08	3.39E-09	1	4.30E-07	4.30E-05	0.1	6.89E-08	3.51E-09	0.1	3.66E-07	3.66E-05	6.90E-09	7.96E-05
Trans-1,2-Dichloroethene	0.0475	0.02	NA	NC	NA	NA	1	1.15E-07	5.74E-06	NC	NA	NA	0.1	9.77E-08	4.89E-06	NA	1.06E-05
Trichloroethane, 1,1,1-	0.0475	0.09	NA	NC	NA	NA	1	1.15E-07	1.28E-06	NC	NA	NA	0.1	9.77E-08	1.09E-06	NA	2.36E-06
Trichloroethene	0.0344	0.002	0.011	1	1.28E-08	1.41E-10	1	8.32E-08	4.16E-05	0.1	1.33E-08	1.46E-10	0.1	7.08E-08	3.54E-05	2.88E-10	7.70E-05
Vinyl chloride	0.0475	0.003	1.4	1.53	2.71E-08	3.80E-08	1	1.15E-07	3.83E-05	0.16	2.94E-08	4.12E-08	0.1	9.77E-08	3.26E-05	7.92E-08	7.08E-05
Total						4.38E-08			3.10E-04			4.72E-08		2.64E-04		9.11E-08	5.74E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-36
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
UnitFirst
Resident at 60 Tufts St.
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$

$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC	EPC	Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-hgpc	Risking	RAFcnc	ADD-inhnc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-hgpc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0475	0.43	1.52E-09	0.43	0.000015	0.0007	0.13	1	2.135E-11	7.473E-11	1.12E-12	8.54E-11	1.11E-11	1	5.29E-11	1.85E-10	4.31E-10	1.59E-10	2.27E-07	1.22E-11	2.27E-07
Chloroethane	0.12	10	3.84E-09	0.66	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.34E-10	4.68E-10	4.68E-11	4.01E-10	1.00E-09	NA	1.05E-09
Chloroform	NA	0.66	NA	0.05	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	0.0475	0.5	1.52E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	5.29E-11	1.85E-10	3.70E-10	1.59E-10	1.59E-09	NA	1.96E-09
Dichloroethane, cis-1,2-	0.0475	0.2	1.52E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	5.29E-11	1.85E-10	5.29E-09	1.59E-10	1.59E-08	NA	2.12E-08
Dichloroethane, 1,1,1-	0.0475	4.6	1.52E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	5.29E-11	1.85E-10	9.28E-10	1.59E-10	3.17E-09	NA	4.10E-09
Tetrachloroethene	0.178	0.07	5.70E-09	0.178	0.00001	0.01	0.051	1	8.001E-11	2.8E-10	2.80E-12	3.2E-10	1.63E-11	1	1.98E-10	6.94E-10	1.51E-10	5.95E-10	5.95E-08	1.91E-11	5.96E-08
Trans-1,2-Dichloroethene	0.0475	5.2	1.52E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	5.29E-11	1.85E-10	2.68E-09	1.59E-10	7.94E-09	NA	1.06E-08
Trichloroethane, 1,1,1-	0.0475	0.18	1.10E-09	0.18	0.0000017	0.002	0.011	1	1.546E-11	5.412E-11	9.20E-14	6.185E-11	6.80E-13	1	3.83E-11	1.34E-10	7.48E-10	1.15E-10	1.76E-09	NA	1.80E-09
Trichloroethene	0.0344	0.1	1.52E-09	0.1	0.0000088	0.003	1.4	1	2.135E-11	7.473E-11	6.58E-13	8.54E-11	1.20E-10	1	5.29E-11	1.85E-10	1.85E-09	1.59E-10	5.75E-08	7.72E-13	5.82E-08
Vinyl chloride	0.0475	0.1	1.52E-09	0.1	0.0000088	0.003	1.4	1	2.135E-11	7.473E-11	6.58E-13	8.54E-11	1.20E-10	1	5.29E-11	1.85E-10	1.85E-09	1.59E-10	5.29E-08	1.20E-10	5.48E-08
Total											4.67E-12		1.48E-10				1.25E-08		4.28E-07	1.52E-10	4.40E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-37

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Resident at 60 Tufts St.
 Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinh	ADE-nc mg/m3	HIinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	5.55E-05	1.11E-04	NA	1.11E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	5.41E-05	1.55E-03	NA	1.55E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	5.41E-05	2.71E-04	NA	2.71E-04
Tetrachloroethene	1.37E-03	4.6	0.00001	1	8.04E-05	8.04E-07	1	1.88E-04	4.08E-05	8.04E-07	4.08E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	5.41E-05	7.73E-04	NA	7.73E-04
Trichloroethane, 1,1,1-	6.24E-04	5.2	NA	NC	NA	NA	1	8.55E-05	1.64E-05	NA	1.64E-05
Trichloroethene	5.75E-04	0.18	0.0000017	1	3.38E-05	5.74E-08	1	7.88E-05	4.38E-04	5.74E-08	4.38E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.50E-05	1.32E-07	1	3.49E-05	3.49E-04	1.32E-07	3.49E-04
Total						9.93E-07			3.54E-03	9.93E-07	3.54E-03

NA - Not available

NC - Not calculated

ND - Not detected

Table A-38
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Commercial Worker at 60 Tufts St.
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	50	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-ci	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPc	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{cs} \times EF \times EP}{AP \times BW}$$
$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$
$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$
$$HI_{der} = \frac{ADD_{der}}{RfD}$$
$$HI = HI_{ing} + HI_{der}$$
$$Risk_{ing} = ADD_{ing} \times CSF$$
$$Risk_{der} = ADD_{der} \times CSF$$
$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total							
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling	RAFdsnc	ADDder-c mg/kg-d	Riskder	RAFdsnc	ADDder-nc mg/kg-d	Hlder	Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride Chloroethane Chloroform Dichloroethane, 1,1- Dichloroethene, cis-1,2- Dichloroethene, 1,1- Tetrachloroethene Trans-1,2-Dichloroethene Trichloroethane, 1,1,1- Trichloroethene vinyl chloride	0.0475	0.0007	0.13	1	4.93E-09	6.41E-10	1	1.28E-08	1.83E-05	0.1	1.03E-09	1.34E-10	0.1	2.66E-09	3.80E-06	7.74E-10	2.21E-05
	0.12	0.4	NA	NC	NA	NA	1	3.23E-08	8.07E-08	NC	NA	NA	0.1	6.73E-09	1.68E-08	NA	9.75E-08
	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	0.1	NA	NA	NA	NA
	0.0475	0.1	NA	NC	NA	NA	1.3	1.66E-08	1.66E-07	NC	NA	NA	0.13	3.46E-09	3.46E-08	NA	2.01E-07
	0.0475	0.01	NA	NC	NA	NA	1	1.28E-08	1.28E-06	NC	NA	NA	0.1	2.66E-09	2.66E-07	NA	1.54E-06
	0.0475	0.05	NA	NC	NA	NA	1	1.28E-08	2.56E-07	NC	NA	NA	0.1	2.66E-09	5.33E-08	NA	3.09E-07
	0.178	0.01	0.051	1	1.85E-08	9.42E-10	1	4.79E-08	4.79E-06	0.1	3.85E-09	1.96E-10	0.1	9.98E-09	9.98E-07	1.14E-09	5.79E-06
	0.0475	0.02	NA	NC	NA	NA	1	1.28E-08	6.39E-07	NC	NA	NA	0.1	2.66E-09	1.33E-07	NA	7.72E-07
	0.0475	0.09	NA	NC	NA	NA	1	1.28E-08	1.42E-07	NC	NA	NA	0.1	2.66E-09	2.96E-08	NA	1.72E-07
	0.0344	0.002	0.011	1	3.57E-09	3.93E-11	1	9.25E-09	4.63E-06	0.1	7.44E-10	8.18E-12	0.1	1.93E-09	9.64E-07	4.75E-11	5.59E-06
	0.0475	0.003	1.4	1.53	7.54E-09	1.06E-08	1	1.28E-08	4.26E-06	0.16	1.64E-09	2.30E-09	0.1	2.66E-09	8.88E-07	1.29E-08	5.15E-06
	Total						1.22E-08			3.45E-05			2.64E-09			7.19E-06	1.48E-08

NA - Not available
NC - Not calculated
ND - Not detected

Table A-39
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Commercial Worker at 60 Tufts St
Ambient Air

Receptor	Commercial/Industrial Worker	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IRair TWA	Outdoor Air TWA Inhalation Rate - Particulates	m3/y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	120	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFiC	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFi-c mg/kg-d	ADE-inc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0475	1.52E-09	0.43	0.000015	0.0007	0.13	1	1.514E-11	5.3E-11	7.95E-13	4.543E-11	5.91E-12	1	3.93E-11	1.37E-10	3.20E-10	1.18E-10	6.70E-12	1.69E-07
Chloroethene	0.12	3.84E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	9.92E-11	3.47E-10	3.47E-11	2.98E-10	NA	7.79E-10
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	0.0475	1.52E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	3.93E-11	1.37E-10	2.75E-10	1.18E-10	NA	1.45E-09
Dichloroethene, cis-1,2-	0.0475	1.52E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	3.93E-11	1.37E-10	3.93E-09	1.18E-10	NA	1.57E-08
Dichloroethene, 1,1-	0.0475	1.52E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	1.47E-10	5.15E-10	6.87E-10	1.18E-10	NA	3.04E-09
Tetrachloroethene	0.178	5.70E-09	4.6	0.00001	0.01	0.051	1	5.674E-11	1.966E-10	1.99E-12	1.702E-10	8.68E-12	1	3.93E-11	1.37E-10	1.12E-10	4.41E-10	1.07E-11	4.42E-08
Trans-1,2-Dichloroethene	0.0475	1.52E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	3.93E-11	1.37E-10	1.96E-09	1.18E-10	NA	7.85E-09
Trichloroethene, 1,1,1-	0.0475	1.52E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	3.93E-11	1.37E-10	2.64E-11	1.18E-10	NA	1.34E-09
Trichloroethene	0.0344	1.10E-09	0.18	0.0000017	0.002	0.011	1	1.097E-11	3.838E-11	6.53E-14	3.29E-11	3.62E-13	1	2.84E-11	9.95E-11	5.53E-10	8.53E-11	4.27E-13	4.32E-08
Vinyl chloride	0.0475	1.52E-09	0.1	0.0000088	0.003	1.4	1	1.514E-11	5.3E-11	4.66E-13	4.543E-11	6.36E-11	1	3.93E-11	1.37E-10	1.37E-09	1.18E-10	6.41E-11	4.06E-08
Total										3.31E-12		7.85E-11				9.27E-09	3.18E-07		3.27E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-40
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Commercial Worker at 60 Tufts St.
Ambient Air

Receptor:	Commercial/Industrial Worker	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$
$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
ATc	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATn	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
C	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane,1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.44E-05	8.88E-05	NA	8.88E-05
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	4.33E-05	1.24E-03	NA	1.24E-03
Dichloroethene,1,1-	3.95E-04	0.2	NA	1	NA	NA	1	4.33E-05	2.16E-04	NA	2.16E-04
Tetrachloroethene	1.37E-03	4.6	0.00001	1	5.79E-05	5.79E-07	1	1.50E-04	3.26E-05	5.79E-07	3.26E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	4.33E-05	6.18E-04	NA	6.18E-04
Trichloroethane,1,1,1-	6.24E-04	5.2	NA	NC	NA	NA	1	6.84E-05	1.32E-05	NA	1.32E-05
Trichloroethene	5.75E-04	0.18	0.0000017	1	2.43E-05	4.13E-08	1	6.30E-05	3.50E-04	4.13E-08	3.50E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.08E-05	9.49E-08	1	2.79E-05	2.79E-04	9.49E-08	2.79E-04
Total						7.15E-07			2.84E-03	7.15E-07	2.84E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-41

Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst

Construction Worker at 60 Tufts St.

Soil - Dermal contact & Incidental Ingestion

Receptor:	Construction Worker
Medium:	Surface Soil
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$
$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$
$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$
$$HI_{der} = \frac{ADD_{der}}{RfD}$$
$$HI = HI_{ing} + HI_{der}$$
$$Risk_{ing} = ADD_{ing} \times CSF$$
$$Risk_{der} = ADD_{der} \times CSF$$
$$Risk = Risk_{ing} + Risk_{der}$$

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.29	
EF	Soil Exposure Frequency	d/y	130	
EP	Soil Exposure Period - Cancer	y	1	
EP	Soil Exposure Period - Non-Cancer	y	1	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	182	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil)	Hl (Soil)						
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosc	ADDing-nc mg/kg-d	Hling			RAFDsc	ADDder-c mg/kg-d	Riskder	RAFDsnc	ADDder-nc mg/kg-d	Hlder
Carbon tetrachloride	0.0475	0.007	0.13	1	4.17E-10	5.42E-11	1	5.85E-08	8.36E-06	0.1	4.20E-10	5.46E-11	0.1	5.89E-08	8.42E-06	1.09E-10	1.68E-05
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	1.48E-07	3.69E-07	NC	NA	NA	0.1	1.49E-07	3.72E-07	NA	7.42E-07
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	0.1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.0475	1	NA	NC	NA	NA	1.3	7.60E-08	7.60E-08	NC	NA	NA	0.13	7.66E-08	7.66E-08	NA	1.53E-07
Dichloroethane, cis-1,2-	0.0475	0.1	NA	NC	NA	NA	1	5.85E-08	5.85E-07	NC	NA	NA	0.1	5.89E-08	5.89E-07	NA	1.17E-06
Dichloroethane, 1,1-	0.0475	0.05	NA	NC	NA	NA	1	5.85E-08	1.17E-06	NC	NA	NA	0.1	5.89E-08	1.18E-06	NA	2.35E-06
Tetrachloroethene	0.178	0.1	0.051	1	1.56E-09	7.96E-11	1	2.19E-07	2.19E-06	0.1	1.57E-09	8.02E-11	0.1	2.21E-07	2.21E-06	1.60E-10	4.40E-06
Trans-1,2-Dichloroethene	0.0475	0.2	NA	NC	NA	NA	1	5.85E-08	2.92E-07	NC	NA	NA	0.1	5.89E-08	2.95E-07	NA	5.87E-07
Trichloroethane, 1,1,1-	0.0475	0.9	NA	NC	NA	NA	1	5.85E-08	6.50E-08	NC	NA	NA	0.1	5.89E-08	6.55E-08	NA	1.30E-07
Trichloroethene	0.0344	0.02	0.011	1	3.02E-10	3.32E-12	1	4.24E-08	2.12E-06	0.1	3.04E-10	3.34E-12	0.1	4.27E-08	2.13E-06	6.66E-12	4.25E-06
Vinyl chloride	0.0475	0.003	1.4	1.53	6.38E-10	8.93E-10	1	5.85E-08	1.95E-05	0.16	6.71E-10	9.40E-10	0.1	5.89E-08	1.96E-05	1.83E-09	3.91E-05
Total						1.03E-09			3.47E-05			1.08E-09			3.50E-05	2.11E-09	6.97E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-42
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Construction Worker at 60 Tufts St.
Ambient Air

Receptor:	Construction Worker	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	dy	130	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	182	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gt} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gt}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gt} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinC	ADD-inhc mg/kg-d	ADE-nc mg/m3	HIinh	ADD-ingnc	HIing	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	4.75E-02	2.85E-09	0.43	0.000015	0.007	0.13	1	3.6E-12	1.26E-11	1.89E-13	1.08E-11	1.40E-12	1	5.05E-10	1.77E-09	4.11E-09	1.52E-09	2.17E-07	1.59E-12	2.21E-07
Chloroethane	1.20E-01	7.20E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.28E-09	4.47E-09	4.47E-10	3.83E-09	9.58E-09	NA	1.00E-08
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,1-	4.75E-02	2.85E-09	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	5.05E-10	1.77E-09	3.54E-10	1.52E-09	1.52E-09	NA	1.87E-09
Dichloroethane, cis-1,2-	4.75E-02	2.85E-09	0.035	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	5.05E-10	1.77E-09	5.05E-08	1.52E-09	1.52E-08	NA	6.57E-08
Dichloroethane, 1,1-	4.75E-02	2.85E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	5.05E-10	1.77E-09	8.84E-09	1.52E-09	3.03E-08	NA	3.92E-08
Tetrachloroethene	1.78E-01	1.07E-08	4.6	0.00001	0.1	0.051	1	1.349E-11	4.722E-11	4.72E-13	4.047E-11	2.06E-12	1	1.89E-09	6.63E-09	1.44E-09	5.68E-09	5.68E-08	2.54E-12	5.83E-08
Trans-1,2-Dichloroethene	4.75E-02	2.85E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	5.05E-10	1.77E-09	2.53E-09	1.52E-09	7.58E-09	NA	1.01E-08
Trichloroethane, 1,1,1-	4.75E-02	2.85E-09	5.2	NA	0.9	NA	NC	NA	NA	NA	NA	NA	1	5.05E-10	1.77E-09	3.40E-10	1.52E-09	1.68E-09	NA	2.02E-09
Trichloroethene	3.44E-02	2.06E-09	0.18	0.0000017	0.02	0.011	1	2.607E-12	9.126E-12	1.55E-14	7.822E-12	8.60E-14	1	3.66E-10	1.28E-09	7.12E-09	1.10E-09	5.49E-08	1.02E-13	6.20E-08
Vinyl chloride	4.75E-02	2.85E-09	0.1	0.0000088	0.003	1.4	1	3.6E-12	1.26E-11	1.11E-13	1.08E-11	1.51E-11	1	5.05E-10	1.77E-09	1.77E-08	1.52E-09	5.05E-07	1.52E-11	5.23E-07
Total										7.88E-13		1.87E-11				9.34E-08		9.00E-07	1.95E-11	9.93E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-43
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 60 Tufts St.

Compound	Henry's Law Constant at Avg GW Temp (conc/conc) H'_{TS}	Deff Vadose Zone (Layer A + Layer B)	Deff Total (Layer A + Layer B + Layer C)	Deffcrack (Layer A)	Exponent of Peclet Number	Organic Carbon- Water Partition Coefficient Koc	Volatilization from Subsurface Soil to Excavation Air VF (mg/m3) / (mg/kg)	Volatilization from Subsurface Soil to Trench Air VF (mg/m3) / (mg/kg)	Volatilization from Soil Gas to Excavation Air Alpha (mg/m3 excav) / (mg/m3 SG)	Volatilization from Soil Gas to Trench Air Alpha (mg/m3 trench) / (mg/m3 SG)	Volatilization from Groundwater to Excavation Air VF (mg/m3) / (mg/L)	Volatilization from Groundwater to Trench Air VF (mg/m3) / (mg/L)
Carbon tetrachloride	5.88E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	152	1.53E-03	6.95E-03	9.35E-05	6.13E-06	3.91E-02	2.56E-03
Chloroethane	4.77E-01	5.35E-02	3.80E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.64E-02	3.25E-04	2.13E-05	1.10E-01	7.21E-03
Chloroform	8.04E-02	2.05E-02	1.46E-02	2.05E-02	1.20E+78	52.5	1.11E-03	5.06E-03	1.25E-04	8.17E-06	7.13E-03	4.67E-04
Dichloroethane, 1,1-	1.24E-01	1.46E-02	1.04E-02	1.46E-02	2.74E+109	53.4	1.15E-03	5.25E-03	8.89E-05	5.83E-06	7.86E-03	5.15E-04
Dichloroethene, cis-1,2-	8.79E-02	1.45E-02	1.03E-02	1.45E-02	2.13E+110	35.5	1.17E-03	5.34E-03	8.82E-05	5.78E-06	5.52E-03	3.62E-04
Dichloroethene, 1,1-	6.34E-01	1.78E-02	1.26E-02	1.78E-02	1.68E+90	65	2.51E-03	1.14E-02	1.08E-04	7.07E-06	4.86E-02	3.18E-03
Tetrachloroethene	3.24E-01	1.42E-02	1.01E-02	1.42E-02	6.04E+112	265	8.42E-04	3.83E-03	8.63E-05	5.65E-06	1.99E-02	1.30E-03
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	9.91E-03	1.40E-02	7.16E+114	38	1.71E-03	7.75E-03	8.48E-05	5.55E-06	1.28E-02	8.42E-04
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	135	1.29E-03	5.85E-03	9.35E-05	6.13E-06	2.43E-02	1.59E-03
Trichloroethene	1.97E-01	1.56E-02	1.11E-02	1.56E-02	6.13E+102	94.3	1.14E-03	5.18E-03	9.47E-05	6.20E-06	1.33E-02	8.70E-04
Vinyl chloride	7.65E-01	2.09E-02	1.49E-02	2.09E-02	4.04E+76	18.6	4.71E-03	2.14E-02	1.27E-04	8.32E-06	6.91E-02	4.52E-03

Table A-44
Site-specific Parameters for Volatilization Calculations
50 Tufts Street, Somerville MA
UnFirst
Construction Worker at 60 Tufts St.

Symbol	(units)	Parameter	Value	Comment
L_{crack}	(cm)	Thickness of foundation	15.0	
f_{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02	
L_f	(15 or 200 cm)	Depth below grade to bottom of enclosed space floor	15	Input either 15 or 200
L_{wt}	(cm)	Depth below grade to water table	462.0768	15.16 Ft.
T_s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)
L_f	(cm)	Source- building separation	447.0768	DEP Default
L_g	(cm)	Length of building	961	DEP Default
W_b	(cm)	Width of building	961	DEP Default
H_b	(cm)	Height of building	488	DEP Default
X_{crack}	(cm)	Floor- wall seam perimeter	3844.00	DEP Default
ER	(1/hr)	Air exchange rate	0.45	DEP Default
$Q_{building}$	(cm³/s)	Bldg. ventilation rate	56334.781	
A_g	(cm²)	Area of enclosed space below grade	923521	
η	(unitless)	Crack- to-total area ratio	0.000416233	
Z_{crack}	(cm)	Crack depth below grade	15.0	
H_{TS}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414	
L_d	(cm)	Diffusion path length	447.0768	
L_p	(cm)	Convection path length	15	
r_{crack}	(cm)	Crack radius	0.10	DEP Default
ΔP	g/cm-s²	Pressure differential between soil surface and enclosed space	40.00	DEP Default
Q_{soil}	(cm³/s)	Average vapor flow rate into bldg.	9.454788E+01	
A_{crack}	(cm²)	Area of crack	384.4	
R_c	(cal/mol-K)	Gas constant	1.9872	
R_1	(atm-m³/mol-K)	Universal gas constant	0.0008205	
R_2	(mmHg-cm³/mol-K)	Universal gas constant	82361	
W_{SA}	(cm)	Width of soil source to ambient air	1524	50 Ft.
I_{SA}	(s)	Averaging time for volatilization from soil to ambient air	15788000	0.5 y
U	(cm/s)	Wind speed	225	
D	(cm)	Mixing height	182.88	6 Ft.
Z_s	(cm)	Depth to soil source	462.0768	15.16 Ft.
Z_{SG}	(cm)	Depth to soil gas source	462.0768	15.16 Ft.
W_E	(cm)	Width of excavation	1524	50 Ft.
L_E	(cm)	Length of excavation	762	25 Ft.
H_E	(cm)	Height of excavation	457.2	15 Ft.
W_{Ec}	(cm)	Width of excavation that is contaminated	1524	50 Ft.
L_{Ec}	(cm)	Length of excavation that is contaminated	762	25 Ft.
H_{Ec}	(cm)	Height of excavation that is contaminated	457.2	15 Ft.
WT	(cm)	Width of trench	457.2	15 Ft.
LT	(cm)	Length of trench	121.92	4 Ft.
HT	(cm)	Height of trench	182.88	6 Ft.
W_{Tc}	(cm)	Width of trench that is contaminated	457.2	15 Ft.
L_{Tc}	(cm)	Length of trench that is contaminated	121.92	4 Ft.
H_{Tc}	(cm)	Height of trench that is contaminated	182.88	6 Ft.
I_{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y
I_{ST}	(s)	Averaging time for volatilization from soil to trench	31536000	1 y
F_E	(unitless)	Fraction of wind speed that occurs in excavation	0.5	
F_T	(unitless)	Fraction of wind speed that occurs in trench	0.1	
d	(cm)	Lower depth of surface soil source	462.0768	15.16 Ft.
ρ_b	(g/cm³)	Vadose zone soil dry bulk density	1.5	Vadose Zone Layer A
n	(unitless)	Vadose zone soil total porosity	0.43	Vadose Zone Layer B
θ_w	(cm³/cm³)	Vadose zone soil water-filled porosity	0.06	Capillary Zone
θ_a	(cm³/cm³)	Vadose zone soil air-filled porosity	0.37	1.5
h	(cm)	Thickness of soil layer	15	0.43
S_{se}	(cm³/cm³)	Vadose zone effective total fluid saturation	415.0313455	0.253258113
k_i	(cm²)	Vadose zone soil intrinsic permeability	0.018567639	0.176741867
k_{rg}	(cm²)	Vadose zone soil relative air permeability	9.92425E-08	0.986637033
k_v	(cm²)	Vadose zone soil effective vapor permeability	9.79163E-08	

Select soil type in vadose zone and capillary zone:

Vadose zone adjacent to building Sand

Capillary zone Sand

Key:

Type in Site-specific values here
Calculated values
Constants
Default parameter values from DEP

Table A-45

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Construction Worker at 60 Tufts St.
 Excavation Air
 Volatilization from Soil Gas

$$C_{air} = \frac{C_{soilgas} \times (VF \text{ or } \alpha) \times SDF}{C_{air} \times RAF_i \times ET \times EF \times EP}$$

$$ADE_{inh} = \frac{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}{RfC}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Receptor:	Construction Worker
Medium of Origin:	Soil Gas
Exposure Medium:	Excavation Air
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil Gas mg/m3	Alpha Volatilization from Soil Gas to Excavation Air (mg/m3 excav) / (mg/m3 SG)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.00855	9.35E-05	1	7.99E-07	0.43	0.000015	1	1.36E-09	2.03E-11	1	9.49E-08	2.21E-07	2.03E-11	2.21E-07
Chloroethane	0.004066667	3.25E-04	1	1.32E-06	10	NA	NC	NA	NA	1	1.57E-07	1.57E-08	NA	1.57E-08
Chloroform	NA	1.25E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.010830714	8.89E-05	1	9.63E-07	5	NA	NC	NA	NA	1	1.14E-07	2.29E-08	NA	2.29E-08
Dichloroethene, cis-1,2-	0.007966667	8.82E-05	1	7.03E-07	0.035	NA	NC	NA	NA	1	8.34E-08	2.38E-06	NA	2.38E-06
Dichloroethene, 1,1-	0.129975714	1.08E-04	1	1.40E-05	0.2	NA	1	NA	NA	1	1.66E-06	8.32E-06	NA	8.32E-06
Tetrachloroethene	5.996666667	8.63E-05	1	5.18E-07	4.6	0.00001	1	8.78E-07	8.78E-09	1	6.14E-05	1.34E-05	8.78E-09	1.34E-05
Trans-1,2-Dichloroethane	0.005465	8.48E-05	1	4.63E-07	0.7	NA	NC	NA	NA	1	5.50E-08	7.86E-08	NA	7.86E-08
Trichloroethane, 1,1,1-	1.160714286	9.35E-05	1	1.09E-04	5.2	NA	NC	NA	NA	1	1.29E-05	2.48E-06	NA	2.48E-06
Trichloroethene	1.162	9.47E-05	1	1.10E-04	0.18	0.000017	1	1.87E-07	3.17E-10	1	1.31E-05	7.26E-05	3.17E-10	7.26E-05
Vinyl chloride	0.003596667	1.27E-04	1	4.57E-07	0.1	0.000088	1	7.75E-10	6.82E-12	1	5.43E-08	5.43E-07	6.82E-12	5.43E-07
Total									9.12E-09			1.00E-04	9.12E-09	1.00E-04

NA - Not available

NC - Not calculated

ND - Not detected

juneupdate_construction 60 tufts.xls - constructVOLtoEXC(soil gas)

Table A-46
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Scmerville MA
UniFirst
Construction Worker at 60 Tufts St.
Excavation Air
Volatilization from Subsurface Soil

Receptor:	Construction Worker	▼
Medium of Origin:	Subsurface Soil	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	VF Volatilization from Subsurface Soil to Excavation Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC	R/C	URF	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.0475	1.53E-03	1	7.27E-05	0.43	0.000015	1	1.23E-07	1.85E-09	1	8.63E-06	2.01E-05	1.85E-09	2.01E-05
Chloroethane	0.12	5.80E-03	1	6.96E-04	10	NA	NC	NA	NA	1	8.26E-05	8.26E-06	NA	8.26E-06
Chloroform	NA	1.11E-03	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.0475	1.15E-03	1	5.48E-05	5	NA	NC	NA	NA	1	6.51E-06	1.30E-06	NA	1.30E-06
Dichloroethane, cis-1,2-	0.0475	1.17E-03	1	5.58E-05	0.035	NA	NC	NA	NA	1	6.62E-06	1.89E-04	NA	1.89E-04
Dichloroethane, 1,1-	0.0475	2.51E-03	1	1.19E-04	0.2	NA	1	NA	NA	1	1.41E-05	7.06E-05	NA	7.06E-05
Tetrachloroethene	0.178	8.42E-04	1	1.50E-04	4.6	0.00001	1	2.54E-07	2.54E-09	1	1.78E-05	3.87E-06	2.54E-09	3.87E-06
Trans-1,2-Dichloroethene	0.0475	1.71E-03	1	8.10E-05	0.7	NA	NC	NA	NA	1	9.62E-06	1.37E-05	NA	1.37E-05
Trichloroethane, 1,1,1-	0.0475	1.29E-03	1	6.12E-05	5.2	NA	NC	NA	NA	1	7.26E-06	1.40E-06	NA	1.40E-06
Trichloroethene	0.0344	1.14E-03	1	3.92E-05	0.18	0.0000017	1	6.65E-08	1.13E-10	1	4.65E-06	2.59E-05	1.13E-10	2.59E-05
Vinyl chloride	0.0475	4.71E-03	1	2.24E-04	0.1	0.0000088	1	3.80E-07	3.34E-09	1	2.66E-05	2.66E-04	3.34E-09	2.66E-04
Total									7.84E-09			6.00E-04	7.84E-09	6.00E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-47

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Construction Worker at 60 Tufts St.
 Excavation Air
 Volatilization from Groundwater

Receptor:	Construction Worker	▼
Medium of Origin:	Groundwater	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 Feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC (mg/L)	VF Volatilization from Groundwater to Excavation Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	5.00E-04	3.91E-02	1	1.95E-05	0.43	0.000015	1	3.31E-08	4.97E-10	1	2.32E-06	5.39E-06	4.97E-10	5.39E-06
Chloroethane	1.00E-03	1.10E-01	1	1.10E-04	10	NA	NC	NA	NA	1	1.31E-05	1.31E-06	NA	1.31E-06
Chloroform	5.00E-04	7.13E-03	1	3.56E-06	0.66	0.000023	1	6.04E-09	1.39E-10	1	4.23E-07	6.41E-07	1.39E-10	6.41E-07
Dichloroethane, 1,1-	4.87E-04	7.86E-03	1	3.82E-06	5	NA	NC	NA	NA	1	4.54E-07	9.08E-08	NA	9.08E-08
Dichloroethene, cis-1,2-	5.00E-04	5.52E-03	1	2.76E-06	0.035	NA	NC	NA	NA	1	3.28E-07	9.36E-06	NA	9.36E-06
Dichloroethene, 1,1-	4.20E-03	4.86E-02	1	2.04E-04	0.2	NA	1	NA	NA	1	2.42E-05	1.21E-04	NA	1.21E-04
Tetrachloroethene	2.91E-02	1.99E-02	1	5.79E-04	4.6	0.00001	1	9.82E-07	9.82E-09	1	6.88E-05	1.49E-05	9.82E-09	1.49E-05
Trans-1,2-Dichloroethene	5.00E-04	1.28E-02	1	6.42E-06	0.7	NA	NC	NA	NA	1	7.63E-07	1.09E-06	NA	1.09E-06
Trichloroethane, 1,1,1-	1.78E-02	2.43E-02	1	4.32E-04	5.2	NA	NC	NA	NA	1	5.13E-05	9.87E-06	NA	9.87E-06
Trichloroethene	6.03E-03	1.33E-02	1	8.01E-05	0.18	0.0000017	1	1.36E-07	2.31E-10	1	9.51E-06	5.28E-05	2.31E-10	5.28E-05
Vinyl chloride	5.00E-04	6.91E-02	1	3.45E-05	0.1	0.0000088	1	5.86E-08	5.15E-10	1	4.10E-06	4.10E-05	5.15E-10	4.10E-05
Total									1.12E-08			2.58E-04	1.12E-08	2.58E-04

NA - Not available
 NC - Not calculated
 ND - Not detected

Table A-48
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at 60 Tufts St.
Excavation Air

Receptor:	Construction Worker	▼	
Medium of Origin:		▼	All 3 media
Exposure Medium:	Excavation Air	▼	
Exposure Area:	Excavation	▼	
Depth:	0-15 feet	▼	
Duration:	Subchronic	▼	

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	3.10E-05	0.43	0.000015	1	5.26E-08	7.89E-10	1	3.68E-06	8.56E-06	7.89E-10	8.56E-06
Chloroethane	2.69E-04	10	NA	NC	NA	NA	1	3.19E-05	3.19E-06	NA	3.19E-06
Chloroform	3.56E-06	0.66	0.000023	1	6.04E-09	1.39E-10	1	4.23E-07	6.41E-07	1.39E-10	6.41E-07
Dichloroethane, 1,1-	1.99E-05	5	NA	NC	NA	NA	1	2.36E-06	4.72E-07	NA	4.72E-07
Dichloroethane, cis-1,2-	1.98E-05	0.035	NA	NC	NA	NA	1	2.35E-06	6.70E-05	NA	6.70E-05
Dichloroethane, 1,1-	1.12E-04	0.2	NA	1	NA	NA	1	1.33E-05	6.67E-05	NA	6.67E-05
Tetrachloroethene	4.16E-04	4.6	0.00001	1	7.05E-07	7.05E-09	1	4.93E-05	1.07E-05	7.05E-09	1.07E-05
Trans-1,2-Dichloroethene	2.93E-05	0.7	NA	NC	NA	NA	1	3.48E-06	4.97E-06	NA	4.97E-06
Trichloroethane, 1,1,1-	2.01E-04	5.2	NA	NC	NA	NA	1	2.38E-05	4.58E-06	NA	4.58E-06
Trichloroethene	7.64E-05	0.18	0.0000017	1	1.30E-07	2.20E-10	1	9.08E-06	5.04E-05	2.20E-10	5.04E-05
Vinyl chloride	8.63E-05	0.1	0.0000088	1	1.46E-07	1.29E-09	1	1.02E-05	1.02E-04	1.29E-09	1.02E-04
Total						9.48E-09			3.20E-04	9.48E-09	3.20E-04

Table A-49
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Current Resident at Alston St.
Soil

Receptor:	Resident
Medium:	Soil
Exposure Area:	Current
Depth:	0-3 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-ci	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPc	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{sa} \times EF \times EP}{AP \times BW}$$

$$ADD_{der-nc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{sa} \times EF}{AP}$$

$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{ds} \times EF}{AP}$$

$$HI_{ing} = \frac{ADD_{ing-nc}}{RfD}$$

$$HI_{der} = \frac{ADD_{der-nc}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing-c} \times CSF$$

$$Risk_{der} = ADD_{der-c} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil) YC-OC-A	HI (Soil) YC			
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosc	ADDder-c mg/kg-d	Riskder					
Carbon tetrachloride	0.055	0.0007	0.13	1	2.05E-08	2.67E-09	1	1.33E-07	1.90E-04	0.1	2.77E-09	1.62E-04	5.44E-09	3.52E-04
Chloroethane	0.14	0.4	NA	NC	NA	NA	1	3.38E-07	8.46E-07	NC	NA	7.20E-07	NA	1.57E-06
Chloroform	0.055	0.01	NA	NA	NA	NA	1	1.33E-07	1.33E-05	NA	NA	1.13E-07	NA	2.46E-05
Dichloroethane, 1,1-	0.055	0.1	NA	NC	NA	NA	1.3	1.73E-07	1.73E-06	NC	NA	1.47E-07	NA	3.20E-06
Dichloroethene, cis-1,2-	0.055	0.01	NA	NC	NA	NA	1	1.33E-07	1.33E-05	NC	NA	1.13E-07	NA	2.46E-05
Dichloroethene, 1,1-	0.055	0.05	NA	NC	NA	NA	1	1.33E-07	2.66E-06	NC	NA	1.13E-07	NA	4.92E-06
Tetrachloroethene	0.055	0.01	0.051	1	2.05E-08	1.05E-09	1	1.33E-07	1.33E-05	0.1	2.13E-08	1.13E-07	2.13E-09	2.46E-05
Trans-1,2-Dichloroethene	0.055	0.02	NA	NC	NA	NA	1	1.33E-07	6.65E-06	NC	NA	1.13E-07	NA	1.23E-05
Trichloroethane, 1,1,1-	0.055	0.09	NA	NC	NA	NA	1	1.33E-07	1.48E-06	NC	NA	1.13E-07	NA	2.73E-06
Trichloroethene	0.055	0.002	0.011	1	2.05E-08	2.26E-10	1	1.33E-07	6.65E-05	0.1	2.13E-08	1.13E-07	4.60E-10	1.23E-04
Vinyl chloride	0.055	0.003	1.4	1.53	3.14E-08	4.40E-08	1	1.33E-07	4.43E-05	0.16	3.41E-08	3.77E-05	9.17E-08	8.20E-05
Total						4.79E-08			3.54E-04		5.18E-08	3.01E-04	9.97E-08	6.55E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-50
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Current Resident at Alston St.
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	0-3 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-hg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$

$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	R/C (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinc	ADD-inhrc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.055	1.76E-09	0.43	0.000015	0.0007	0.13	1	2.472E-11	8.652E-11	1.30E-12	9.888E-11	1.29E-11	1	6.13E-11	2.14E-10	4.99E-10	1.84E-10	2.63E-07	2.63E-07	
Chloroethane	0.14	4.48E-09	10	0.000015	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.56E-10	5.46E-10	5.46E-11	4.68E-10	1.17E-09	1.22E-09	
Chloroform	0.055	1.76E-09	0.66	0.000023	0.01	NA	1	2.472E-11	8.652E-11	1.99E-12	NA	NA	1	6.13E-11	2.14E-10	3.25E-10	1.84E-10	1.84E-08	1.87E-08	
Dichloroethane, 1,1-	0.055	1.76E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	6.13E-11	2.14E-10	4.29E-10	1.84E-10	1.84E-09	2.27E-09	
Dichloroethane, cis-1,2-	0.055	1.76E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	6.13E-11	2.14E-10	6.13E-09	1.84E-10	1.84E-08	2.45E-08	
Dichloroethene, 1,1-	0.055	1.76E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	6.13E-11	2.14E-10	1.07E-09	1.84E-10	3.68E-09	4.75E-09	
Tetrachloroethene	0.055	1.76E-09	4.6	0.00001	0.01	0.051	1	2.472E-11	8.652E-11	8.65E-13	9.888E-11	5.04E-12	1	6.13E-11	2.14E-10	4.66E-11	1.84E-10	5.91E-12	1.84E-08	
Trans-1,2-Dichloroethene	0.055	1.76E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	6.13E-11	2.14E-10	3.06E-09	1.84E-10	9.19E-09	1.23E-08	
Trichloroethane, 1,1,1-	0.055	1.76E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	6.13E-11	2.14E-10	4.12E-11	1.84E-10	2.04E-09	2.08E-09	
Trichloroethene	0.055	1.76E-09	0.18	0.0000017	0.002	0.011	1	2.472E-11	8.652E-11	1.47E-13	9.888E-11	1.09E-12	1	6.13E-11	2.14E-10	1.19E-09	1.84E-10	1.23E-12	9.31E-08	
Vinyl chloride	0.055	1.76E-09	0.1	0.0000088	0.003	1.4	1	2.472E-11	8.652E-11	7.61E-13	9.888E-11	1.38E-10	1	6.13E-11	2.14E-10	2.14E-09	1.84E-10	1.39E-10	6.34E-08	
Total										5.06E-12		1.57E-10				1.50E-08		4.89E-07	5.04E-07	

NA - Not available
NC - Not calculated
ND - Not detected

Table A-51
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Resident at Alston St.
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	5.55E-05	1.11E-04	NA	1.11E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	5.41E-05	1.55E-03	NA	1.55E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	5.41E-05	2.71E-04	NA	2.71E-04
Tetrachloroethene	7.00E-04	4.6	0.00001	1	4.11E-05	4.11E-07	1	9.59E-05	2.08E-05	4.11E-07	2.08E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	5.41E-05	7.73E-04	NA	7.73E-04
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	7.53E-05	1.45E-05	NA	1.45E-05
Trichloroethene	5.50E-04	0.18	0.000017	1	3.23E-05	5.49E-08	1	7.53E-05	4.19E-04	5.49E-08	4.19E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.50E-05	1.32E-07	1	3.49E-05	3.49E-04	1.32E-07	3.49E-04
Total						5.98E-07			3.50E-03	5.98E-07	3.50E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-52
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Resident at Alston St.
Soil

Receptor:	Resident
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-ci	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPc	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der-nc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{os} \times EF}{AP}$$

$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{ds} \times EF}{AP}$$

$$HI_{ing} = \frac{ADD_{ing-nc}}{RfD}$$

$$HI_{der} = \frac{ADD_{der-nc}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing-c} \times CS'$$

$$Risk_{der} = ADD_{der-c} \times CSF'$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil) YC-OC-A	HI (Soil) YC					
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling			RAFdsnc	ADDder-c mg/kg-d	Riskder	ADDder-nc mg/kg-d	Hlder
Carbon tetrachloride	0.045	0.0007	0.13	1	1.68E-08	2.18E-09	1	1.09E-07	1.55E-04	0.1	1.74E-08	2.26E-09	0.1	9.26E-08	1.32E-04	2.88E-04
Chloroethane	0.11	0.4	NA	NC	NA	NA	1	2.66E-07	6.65E-07	NC	NA	NA	0.1	2.26E-07	5.66E-07	1.23E-06
Chloroform	0.045	0.01	NA	NA	NA	NA	1	1.09E-07	1.09E-05	NA	NA	NA	0.1	9.26E-08	9.26E-06	2.01E-05
Dichloroethane, 1,1-	0.045	0.1	NA	NC	NA	NA	1.3	1.41E-07	1.41E-06	NC	NA	NA	0.13	1.20E-07	1.20E-06	2.62E-06
Dichloroethene, cis-1,2-	0.045	0.01	NA	NC	NA	NA	1	1.09E-07	1.09E-05	NC	NA	NA	0.1	9.26E-08	9.26E-06	2.01E-05
Dichloroethene, 1,1-	0.045	0.05	NA	NC	NA	NA	1	1.09E-07	2.18E-06	NC	NA	NA	0.1	9.26E-08	1.85E-06	4.03E-06
Tetrachloroethene	0.045	0.01	0.051	1	1.68E-08	8.57E-10	1	1.09E-07	1.09E-05	0.1	1.74E-08	8.88E-10	0.1	9.26E-08	9.26E-06	1.75E-09
Trans-1,2-Dichloroethene	0.045	0.02	NA	NC	NA	NA	1	1.09E-07	5.44E-06	NC	NA	NA	0.1	9.26E-08	4.63E-06	2.01E-05
Trichloroethane, 1,1,1-	0.045	0.09	NA	NC	NA	NA	1	1.09E-07	1.21E-06	NC	NA	NA	0.1	9.26E-08	1.03E-06	1.01E-05
Trichloroethene	0.045	0.002	0.011	1	1.68E-08	1.85E-10	1	1.09E-07	5.44E-05	0.1	1.74E-08	1.92E-10	0.1	9.26E-08	4.63E-05	3.76E-10
Vinyl chloride	0.045	0.003	1.4	1.53	2.57E-08	3.60E-08	1	1.09E-07	3.63E-05	0.16	2.79E-08	3.90E-08	0.1	9.26E-08	3.09E-05	6.71E-05
Total						3.92E-08			2.90E-04			4.24E-08			2.46E-04	8.16E-08

NA - Not available
NC - Not calculated
ND - Not detected

Table A-53
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Straat, Somerville MA
UnFirst
Futura Resident at Alston St.
Ambiant Air

Receptor:	Resident	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times IET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$
$$ADD_{inh-r} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$
$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$
$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-r} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinC	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulas in Air) YC-OC-A	HI (Particulas in Air) YC
Carbon tetrachlorida	0.045	1.44E-09	0.43	0.000015	0.0007	0.13	1	2.023E-11	7.079E-11	1.06E-12	8.091E-11	1.05E-11	1	5.01E-11	1.75E-10	4.08E-10	1.50E-10	2.15E-07	1.16E-11	2.15E-07
Chloroathane	0.11	3.52E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.23E-10	4.29E-10	4.29E-11	3.68E-10	9.19E-10	NA	9.62E-10
Chloroform	0.045	1.44E-09	0.66	0.000023	0.01	NA	1	2.023E-11	7.079E-11	1.63E-12	NA	NA	1	5.01E-11	1.75E-10	2.68E-10	1.50E-10	1.50E-08	1.63E-12	1.53E-08
Dichloroethane, 1,1-	0.045	1.44E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	5.01E-11	1.75E-10	3.51E-10	1.50E-10	1.50E-09	NA	1.85E-09
Dichloroethene, cis-1,2-	0.045	1.44E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	5.01E-11	1.75E-10	5.01E-09	1.50E-10	1.50E-08	NA	2.01E-08
Dichloroethene, 1,1-	0.045	1.44E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	5.01E-11	1.75E-10	8.77E-10	1.50E-10	3.01E-09	NA	3.88E-09
Trichloroethylene	0.045	1.44E-09	4.6	0.00001	0.01	0.051	1	2.023E-11	7.079E-11	7.08E-13	8.091E-11	4.13E-12	1	5.01E-11	1.75E-10	3.81E-11	1.50E-10	1.50E-08	4.83E-12	1.51E-08
Trans-1,2-Dichloroethene	0.045	1.44E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	5.01E-11	1.75E-10	2.51E-09	1.50E-10	7.52E-09	NA	1.00E-08
Trichloroethane, 1,1,1-	0.045	1.44E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	5.01E-11	1.75E-10	3.37E-11	1.50E-10	1.67E-09	NA	1.70E-09
Trichloroethene	0.045	1.44E-09	0.18	0.0000017	0.002	0.011	1	2.023E-11	7.079E-11	1.20E-13	8.091E-11	8.90E-13	1	5.01E-11	1.75E-10	9.75E-10	1.50E-10	7.52E-08	1.01E-12	7.62E-08
Vinyl chloride	0.045	1.44E-09	0.1	0.0000088	0.003	1.4	1	2.023E-11	7.079E-11	6.23E-13	8.091E-11	1.13E-10	1	5.01E-11	1.75E-10	1.75E-09	1.50E-10	5.01E-08	1.14E-10	5.19E-08
Total										4.14E-12		1.29E-10				1.29E-08		4.00E-07	1.33E-10	4.12E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-54
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Resident at Alston St.
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air data	RfC (mg/m3)	URF 1/(ug/m3)	RAFc	ADE-c mg/m3	Riskinh	RAFinh	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	5.55E-05	1.11E-04	NA	1.11E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	5.41E-05	1.55E-03	NA	1.55E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	5.41E-05	2.71E-04	NA	2.71E-04
Tetrachloroethene	7.00E-04	4.6	0.00001	1	4.11E-05	4.11E-07	1	9.59E-05	2.08E-05	4.11E-07	2.08E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	5.41E-05	7.73E-04	NA	7.73E-04
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	7.53E-05	1.45E-05	NA	1.45E-05
Trichloroethene	5.50E-04	0.18	0.0000017	1	3.23E-05	5.49E-08	1	7.53E-05	4.19E-04	5.49E-08	4.19E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.50E-05	1.32E-07	1	3.49E-05	3.49E-04	1.32E-07	3.49E-04
Total						5.98E-07			3.50E-03	5.98E-07	3.50E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-55
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Commercial Worker at Alston St.
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	50	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-c	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPc	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{dt} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{R/D}$$

$$HI_{der} = \frac{ADD_{der}}{R/D}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	R/D (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil) YC-OC-A	HI (Soil) YC
				RAFOsc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling		
Carbon tetrachloride	0.045	0.0007	0.13	1	4.67E-09	6.07E-10	1	1.21E-08	1.73E-05	7.34E-10	2.09E-05
Chloroethane	0.11	0.4	NA	NC	NA	NA	1	2.96E-08	7.40E-08	NA	8.94E-08
Chloroform	0.045	0.01	NA	NC	NA	NA	1	1.21E-08	1.21E-06	NA	1.46E-06
Dichloroethane, 1,1-	0.045	0.1	NA	NC	NA	NA	1.3	1.57E-08	1.57E-07	NA	1.90E-07
Dichloroethene, cis-1,2-	0.045	0.01	NA	NC	NA	NA	1	1.21E-08	1.21E-06	NA	1.46E-06
Dichloroethene, 1,1-	0.045	0.05	NA	NC	NA	NA	1	1.21E-08	2.42E-07	NA	2.93E-07
Tetrachloroethene	0.045	0.01	0.051	1	4.67E-09	2.38E-10	1	1.21E-08	1.21E-06	2.88E-10	1.46E-06
Trans-1,2-Dichloroethene	0.045	0.02	NA	NC	NA	NA	1	1.21E-08	6.05E-07	NA	7.31E-07
Trichloroethane, 1,1,1-	0.045	0.09	NA	NC	NA	NA	1	1.21E-08	1.35E-07	NA	1.63E-07
Trichloroethene	0.045	0.002	0.011	1	4.67E-09	5.14E-11	1	1.21E-08	6.05E-06	6.21E-11	7.31E-06
Vinyl chloride	0.045	0.003	1.4	1.53	7.14E-09	1.00E-08	1	1.21E-08	4.04E-06	1.22E-08	4.88E-06
Total						1.09E-08			3.22E-05	1.33E-08	3.89E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-56
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tutis Street, Somerville MA
UnitFirst
Commercial Worker at Alston St.
Ambient Air

Receptor:	Commercial/Industrial Worker	
Medium of Origin:	Soil	
Exposure Medium:	Ambient Air	
Exposure Area:	Future	
Depth:	0-15 feet	
Duration:	Chronic	

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	120	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC	Soil (mg/kg)	EPC	Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinC	ADD-inhmc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride		0.045		1.44E-09	0.43	0.000015	0.0007	0.13	1	1.435E-11	5.021E-11	7.53E-13	4.304E-11	5.59E-12	1	3.72E-11	1.30E-10	3.03E-10	1.12E-10	1.59E-07	6.35E-12	1.60E-07
Chloroethane		0.11		3.52E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	9.09E-11	3.18E-10	3.18E-11	2.73E-10	6.82E-10	NA	7.14E-10
Chloroform		0.045		1.44E-09	0.66	0.000023	0.01	NA	1	1.435E-11	5.021E-11	1.15E-12	NA	NA	1	3.72E-11	1.30E-10	1.97E-10	1.12E-10	1.12E-08	1.15E-12	1.14E-08
Dichloroethane, 1,1-		0.045		1.44E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	3.72E-11	1.30E-10	2.60E-10	1.12E-10	1.12E-09	NA	1.38E-09
Dichloroethane, cis-1,2-		0.045		1.44E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	3.72E-11	1.30E-10	3.72E-09	1.12E-10	1.12E-08	NA	1.49E-08
Dichloroethane, 1,1,1-		0.045		1.44E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	3.72E-11	1.30E-10	6.51E-10	1.12E-10	2.23E-09	NA	2.88E-09
Tetrachloroethene		0.045		1.44E-09	4.6	0.00001	0.01	0.051	1	1.435E-11	5.021E-11	5.02E-13	4.304E-11	2.19E-12	1	3.72E-11	1.30E-10	2.83E-11	1.12E-10	1.12E-08	2.70E-12	1.12E-08
Trans-1,2-Dichloroethene		0.045		1.44E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	3.72E-11	1.30E-10	1.86E-09	1.12E-10	5.58E-09	NA	7.44E-09
Trichloroethane, 1,1,1-		0.045		1.44E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	3.72E-11	1.30E-10	2.50E-11	1.12E-10	1.24E-09	NA	1.26E-09
Trichloroethene		0.045		1.44E-09	0.18	0.0000017	0.002	0.011	1	1.435E-11	5.021E-11	8.54E-14	4.304E-11	4.79E-13	1	3.72E-11	1.30E-10	7.23E-11	1.12E-10	5.58E-08	5.59E-13	5.65E-08
Vinyl chloride		0.045		1.44E-09	0.1	0.0000088	0.003	1.4	1	1.435E-11	5.021E-11	4.42E-13	4.304E-11	6.03E-11	1	3.72E-11	1.30E-10	1.30E-09	1.12E-10	3.72E-08	6.07E-11	3.85E-08
Total												2.94E-12		6.85E-11				9.10E-09		2.97E-07	7.15E-11	3.06E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-57

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Commercial Worker at Alston St.
 Ambient Air

Receptor:	Commercial/Industrial Worker	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	Riskinh	RAFiC	ADE-nc mg/m3	HIinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.44E-05	8.88E-05	NA	8.88E-05
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	4.33E-05	1.24E-03	NA	1.24E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	4.33E-05	2.16E-04	NA	2.16E-04
Tetrachloroethene	7.00E-04	4.6	0.00001	1	2.96E-05	2.96E-07	1	7.67E-05	1.67E-05	2.96E-07	1.67E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	4.33E-05	6.18E-04	NA	6.18E-04
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	6.03E-05	1.16E-05	NA	1.16E-05
Trichloroethene	5.50E-04	0.18	0.000017	1	2.32E-05	3.95E-08	1	6.03E-05	3.35E-04	3.95E-08	3.35E-04
Vinyl chloride	2.55E-04	0.1	0.000088	1	1.08E-05	9.49E-08	1	2.79E-05	2.79E-04	9.49E-08	2.79E-04
Total						4.30E-07			2.80E-03	4.30E-07	2.80E-03

NA - Not available
 NC - Not calculated
 ND - Not detected

Table A-58
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
Unifirst
Construction Worker at Alston St.
Soil - Dermal contact & Incidental Ingestion

Receptor:	Construction Worker	▼
Medium:	Surface Soil	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.29	
EF	Soil Exposure Frequency	d/y	130	
EP	Soil Exposure Period - Cancer	y	1	
EP	Soil Exposure Period - Non-Cancer	y	1	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	182	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil)	HI (Soil)
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling		
Carbon tetrachloride	0.045	0.007	0.13	1	3.95E-10	5.13E-11	1	5.54E-08	7.92E-06	1.03E-10	1.59E-05
Chloroethane	0.11	0.4	NA	NC	NA	NA	1	1.35E-07	3.39E-07	NA	6.80E-07
Chloroform	0.045	0.01	NA	NA	NA	NA	1	5.54E-08	5.54E-06	NA	1.11E-05
Dichloroethane, 1,1-	0.045	1	NA	NC	NA	NA	1.3	7.20E-08	7.20E-08	NA	1.45E-07
Dichloroethene, cis-1,2-	0.045	0.1	NA	NC	NA	NA	1	5.54E-08	5.54E-07	NA	1.11E-06
Dichloroethene, 1,1-	0.045	0.05	NA	NC	NA	NA	1	5.54E-08	1.11E-06	NA	2.22E-06
Tetrachloroethene	0.045	0.1	0.051	1	3.95E-10	2.01E-11	1	5.54E-08	5.54E-07	4.04E-11	1.11E-06
Trans-1,2-Dichloroethene	0.045	0.2	NA	NC	NA	NA	1	5.54E-08	2.77E-07	NA	5.56E-07
Trichloroethane, 1,1,1-	0.045	0.9	NA	NC	NA	NA	1	5.54E-08	6.16E-08	NA	1.24E-07
Trichloroethene	0.045	0.02	0.011	1	3.95E-10	4.34E-12	1	5.54E-08	2.77E-06	8.72E-12	5.56E-06
Vinyl chloride	0.045	0.003	1.4	1.53	6.04E-10	8.46E-10	1	5.54E-08	1.85E-05	1.74E-09	3.71E-05
Total						9.21E-10			3.77E-05	1.89E-09	7.56E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-59
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Construction Worker at Alston St.
Ambient Air

Receptor	Construction Worker	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gt} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gt}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gt} \times CSF) + (ADE_{inh} \times URF \times C)$$

Parameter	Description	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRair TWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	130	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	d	25550	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	182	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	kg	58.0	
BW	Body Weight	kg	1000	
C	Conversion Factor	ug/mg		

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inh-c mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinc	ADD-inhnc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	4.50E-02	2.70E-09	0.43	0.000015	0.007	0.13	1	3.411E-12	1.194E-11	1.79E-13	1.023E-11	1.33E-12	1	4.79E-10	1.68E-09	3.90E-09	1.44E-09	2.05E-07	1.51E-12	2.09E-07
Chloroethane	1.10E-01	6.60E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.17E-09	4.10E-09	4.10E-10	3.51E-09	8.78E-09	NA	9.19E-09
Chloroform	4.50E-02	2.70E-09	0.66	0.000023	0.01	NA	1	3.411E-12	1.194E-11	2.75E-13	NA	NA	1	4.79E-10	1.68E-09	2.54E-09	1.44E-09	1.44E-07	2.75E-13	1.46E-07
Dichloroethane, 1,1-	4.50E-02	2.70E-09	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	4.79E-10	1.68E-09	3.35E-10	1.44E-09	1.44E-09	NA	1.77E-09
Dichloroethene, cis-1,2-	4.50E-02	2.70E-09	0.035	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	4.79E-10	1.68E-09	4.79E-08	1.44E-09	1.44E-08	NA	6.22E-08
Dichloroethene, 1,1-	4.50E-02	2.70E-09	0.2	NA	0.05	NA	1	NA	NA	1.19E-13	NA	NA	1	4.79E-10	1.68E-09	8.38E-09	1.44E-09	2.87E-08	NA	3.71E-08
Tetrachloroethene	4.50E-02	2.70E-09	4.6	0.00001	0.1	0.051	1	3.411E-12	1.194E-11	1.023E-11	1.023E-11	5.22E-13	1	4.79E-10	1.68E-09	3.64E-10	1.44E-09	1.44E-08	6.41E-13	1.47E-08
Trans-1,2-Dichloroethene	4.50E-02	2.70E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	4.79E-10	1.68E-09	2.39E-09	1.44E-09	7.18E-09	NA	9.58E-09
Trichloroethane, 1,1,1-	4.50E-02	2.70E-09	5.2	NA	0.9	NA	NC	NA	NA	2.03E-14	1.023E-11	1.13E-13	1	4.79E-10	1.68E-09	3.22E-10	1.44E-09	1.60E-09	NA	1.92E-09
Trichloroethene	4.50E-02	2.70E-09	0.18	0.0000017	0.02	0.011	1	3.411E-12	1.194E-11	1.05E-13	1.023E-11	1.43E-11	1	4.79E-10	1.68E-09	9.31E-09	1.44E-09	7.18E-08	1.33E-13	8.11E-08
Vinyl chloride	4.50E-02	2.70E-09	0.1	0.0000088	0.003	1.4	1	3.411E-12	1.194E-11	1.05E-13	1.023E-11	1.43E-11	1	4.79E-10	1.68E-09	1.68E-08	1.44E-09	4.79E-07	1.44E-11	4.96E-07
Total										6.98E-13		1.63E-11				9.26E-08		9.76E-07	1.70E-11	1.07E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-60
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at Alston St.

Compound	Henry's Law Constant at Avg GW Temp (conc/conc) H ⁺ _{TS}	Deff Vadose Zone (Layer A + Layer B)	Deff Total (Layer A + Layer B + Layer C)	Deffcrack (Layer A)	Exponent of Peclet Number	Organic Carbon- Water Partition Coefficient Koc	Volatilization from Subsurface Soil to Excavation Air VF	(mg/m3) / (mg/kg)	Volatilization from Subsurface Soil to Trench Air VF	(mg/m3) / (mg/kg)	Volatilization from Soil Gas to Excavation Air Alpha	(mg/m3 excav) / (mg/m3 SG)	Volatilization from Soil Gas to Trench Air Alpha (mg/m3 trench) / (mg/m3 SG)	Volatilization from Groundwater to Excavation Air VF	(mg/m3) / (mg/L)	Volatilization from Groundwater to Trench Air VF	(mg/m3) / (mg/L)
Compound	(conc/conc)	(cm2/sec)	(cm2/sec)	(cm2/sec)		(cm3/g)											
Carbon tetrachloride	5.88E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	152	1.53E-03	6.95E-03	9.35E-05	6.13E-06	3.91E-02	2.56E-03	3.91E-02	2.56E-03			
Chloroethane	4.77E-01	5.35E-02	3.80E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.64E-02	3.25E-04	2.13E-05	1.10E-01	7.21E-03	1.10E-01	7.21E-03			
Chloroform	8.04E-02	2.05E-02	1.46E-02	2.05E-02	1.20E+78	52.5	1.11E-03	5.06E-03	1.25E-04	8.17E-06	7.13E-03	4.67E-04	7.13E-03	4.67E-04			
Dichloroethane, 1,1-	1.24E-01	1.46E-02	1.04E-02	1.46E-02	2.74E+109	53.4	1.15E-03	5.25E-03	8.89E-05	5.83E-06	7.86E-03	5.15E-04	7.86E-03	5.15E-04			
Dichloroethene, cis-1,2-	8.79E-02	1.45E-02	1.03E-02	1.45E-02	2.13E+110	35.5	1.17E-03	5.34E-03	8.82E-05	5.78E-06	5.52E-03	3.62E-04	5.52E-03	3.62E-04			
Dichloroethene, 1,1-	6.34E-01	1.78E-02	1.26E-02	1.78E-02	1.68E+90	65	2.51E-03	1.14E-02	1.08E-04	7.07E-06	4.86E-02	3.18E-03	4.86E-02	3.18E-03			
Tetrachloroethene	3.24E-01	1.42E-02	1.01E-02	1.42E-02	6.04E+112	265	8.42E-04	3.83E-03	8.63E-05	5.65E-06	1.99E-02	1.30E-03	1.99E-02	1.30E-03			
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	9.91E-03	1.40E-02	7.16E+114	38	1.71E-03	7.75E-03	8.48E-05	5.55E-06	1.28E-02	8.42E-04	1.28E-02	8.42E-04			
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	135	1.29E-03	5.85E-03	9.35E-05	6.13E-06	2.43E-02	1.59E-03	2.43E-02	1.59E-03			
Trichloroethene	1.97E-01	1.56E-02	1.11E-02	1.56E-02	6.13E+102	94.3	1.14E-03	5.18E-03	9.47E-05	6.20E-06	1.33E-02	8.70E-04	1.33E-02	8.70E-04			
Vinyl chloride	7.65E-01	2.09E-02	1.49E-02	2.09E-02	4.04E+76	18.6	4.71E-03	2.14E-02	1.27E-04	8.32E-06	6.91E-02	4.52E-03	6.91E-02	4.52E-03			

Symbol (units) Parameter Value Comment

L_{crack}	(cm)	Thickness of foundation	15.0	
f_{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02	
L_f	(15 or 200 cm)	Depth below grade to bottom of enclosed space floor	15	Input either 15 or 200
L_{wrt}	(cm)	Depth below grade to water table	462.0768	15.16 Ft.
T_s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)
L_i	(cm)	Source- building separation	447.0768	DEP Default
L_b	(cm)	Length of building	961	DEP Default
W_b	(cm)	Width of building	961	DEP Default
H_b	(cm)	Height of building	488	DEP Default
X_{crack}	(cm)	Floor- wall seam perimeter	3844.00	
ER	(1/hr)	Air exchange rate	0.45	DEP Default
$Q_{building}$	(cm ³ /s)	Bldg. ventilation rate	56334.781	
A_g	(cm ²)	Area of enclosed space below grade	923521	
η	(unitless)	Crack- to-total area ratio	0.000416233	
Z_{crack}	(cm)	Crack depth below grade	15.0	
η_{15}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414	
L_d	(cm)	Diffusion path length	447.0768	
L_p	(cm)	Convection path length	15	
r_{crack}	(cm)	Crack radius	0.10	DEP Default
ΔP	g/cm-s ²	Pressure differential between soil surface and enclosed space	40.00	DEP Default
O_{soil}	(cm ³ /s)	Average vapor flow rate into bldg.	9.454788E+01	
A_{crack}	(cm ²)	Area of crack	384.4	
RC	(cal/mol-K)	Gas constant	1.9872	
R	(atm-m ³ /mol-K)	Universal gas constant	0.0008205	
R2	(mmHg-cm ³ /mol-K)	Universal gas constant	82061	
W_{SA}	(cm)	Width of soil source to ambient air	1524	50 Ft.
t_{SA}	(s)	Averaging time for volatilization from soil to ambient air	15768000	0.5 y
U	(cm/s)	Wind speed	225	
D	(cm)	Mixing height	182.88	6 Ft.
Z_s	(cm)	Depth to soil source	462.0768	15.16 Ft.
Z_{sg}	(cm)	Depth to soil gas source	462.0768	15.16 Ft.
W_E	(cm)	Width of excavation	1524	50 Ft.
L_E	(cm)	Length of excavation	762	25 Ft.
H_E	(cm)	Height of excavation	457.2	15 Ft.
W_{Ee}	(cm)	Width of excavation that is contaminated	1524	50 Ft.
L_{Ee}	(cm)	Length of excavation that is contaminated	762	25 Ft.
H_{Ee}	(cm)	Height of excavation that is contaminated	457.2	15 Ft.
WT	(cm)	Width of trench	457.2	15 Ft.
LT	(cm)	Length of trench	121.92	4 Ft.
HT	(cm)	Height of trench	182.88	6 Ft.
WTC	(cm)	Width of trench that is contaminated	457.2	15 Ft.
LTC	(cm)	Length of trench that is contaminated	121.92	4 Ft.
HTC	(cm)	Height of trench that is contaminated	182.88	6 Ft.
t_{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y
t_{ST}	(s)	Averaging time for volatilization from soil to trench	31536000	1 y
F_E	(unitless)	Fraction of wind speed that occurs in excavation	0.5	
F_T	(unitless)	Fraction of wind speed that occurs in trench	0.1	
d	(cm)	Lower depth of surface soil source	462.0768	15.16 Ft.

		Vadose Zone	Vadose Zone	Capillary Zone
		Layer A	Layer B	
P_b	(g/cm ³)	1.5	1.5	1.5
n	(unitless)	0.43	0.43	0.43
α_w	(cm ³ /cm ³)	0.06	0.06	0.253258113
θ_w	(cm ³ /cm ³)	0.37	0.37	0.176741887
h	(cm)	15	415.0313455	17.04545455
S_{we}	(cm ³ /cm ³)			0.018567639
k_i	(cm ²)			9.92425E-08
k_a	(cm ²)			0.986637033
k_v	(cm ²)			9.79163E-08

Select soil type in vadose zone and capillary zone:

Vadose zone adjacent to building

Sand

Capillary zone

Sand

Key:

Type In Site-specific values here
Calculated values
Consistent
Default parameter values from DEP

Values Assume all sources are 1 inch below excavation depth

Table A-62

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA

UniFirst

Construction Worker at Alston St.

Excavation Air

Volatilization from Soil Gas

Receptor:	Construction Worker	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	Alpha Volatilization from Soil Gas to Excavation Air (mg/m3 excav) / (mg/m3 SG)	Source Dilution Factor	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.00317	9.35E-05	1	2.96E-07	0.43	0.000015	1	5.03E-10	7.54E-12	1	3.52E-08	8.18E-08	7.54E-12	8.18E-08
Chloroethane	0.001438333	3.25E-04	1	4.67E-07	10	NA	NC	NA	NA	1	5.55E-08	5.55E-09	NA	5.55E-09
Chloroform	NA	1.25E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.0010125	8.89E-05	1	9.01E-08	5	NA	NC	NA	NA	1	1.07E-08	2.14E-09	NA	2.14E-09
Dichloroethane, cis-1,2-	0.000902857	8.82E-05	1	7.97E-08	0.035	NA	NC	NA	NA	1	9.46E-09	2.70E-07	NA	2.70E-07
Dichloroethane, 1,1-	0.001032143	1.08E-04	1	1.11E-07	0.2	NA	1	NA	NA	1	1.32E-08	6.61E-08	NA	6.61E-08
Tetrachloroethene	0.022	8.63E-05	1	1.90E-06	4.6	0.00001	1	3.22E-09	3.22E-11	1	2.25E-07	4.90E-08	3.22E-11	4.90E-08
Trans-1,2-Dichloroethene	0.000902857	8.48E-05	1	7.65E-08	0.7	NA	NC	NA	NA	1	9.08E-09	1.30E-08	NA	1.30E-08
Trichloroethane, 1,1,1-	0.001696667	9.35E-05	1	1.59E-07	5.2	NA	NC	NA	NA	1	1.88E-08	3.62E-09	NA	3.62E-09
Trichloroethene	0.002943333	9.47E-05	1	2.79E-07	0.18	0.0000017	1	4.73E-10	8.04E-13	1	3.31E-08	1.84E-07	8.04E-13	1.84E-07
Vinyl chloride	0.000655	1.27E-04	1	8.32E-08	0.1	0.0000088	1	1.41E-10	1.24E-12	1	9.88E-09	9.88E-08	1.24E-12	9.88E-08
Total									4.18E-11			7.74E-07	4.18E-11	7.74E-07

NA - Not available

NC - Not calculated

ND - Not detected

Table A-63

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at Alston St.
Excavation Air
Volatilization from Subsurface Soil

Receptor:	Construction Worker	▼
Medium of Origin:	Subsurface Soil	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Subsurface Soil mg/kg	VF Volatilization from Subsurface Soil to Excavation Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	Riskinh	RAFiC	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.045	1.53E-03	1	6.88E-05	0.43	0.000015	1	1.17E-07	1.75E-09	1	8.17E-06	1.90E-05	1.75E-09	1.90E-05
Chloroethane	0.11	5.80E-03	1	6.38E-04	10	NA	NC	NA	NA	1	7.57E-05	7.57E-06	NA	7.57E-06
Chloroform	0.045	1.11E-03	1	5.01E-05	0.66	0.000023	1	8.50E-08	1.95E-09	1	5.95E-06	9.01E-06	1.95E-09	9.01E-06
Dichloroethane, 1,1-	0.045	1.15E-03	1	5.19E-05	5	NA	NC	NA	NA	1	6.17E-06	1.23E-06	NA	1.23E-06
Dichloroethane, cis-1,2-	0.045	1.17E-03	1	5.29E-05	0.035	NA	NC	NA	NA	1	6.28E-06	1.79E-04	NA	1.79E-04
Dichloroethane, 1,1-	0.045	2.51E-03	1	1.13E-04	0.2	NA	1	NA	NA	1	1.34E-05	6.69E-05	NA	6.69E-05
Tetrachloroethane	0.045	8.42E-04	1	3.79E-05	4.6	0.00001	1	6.42E-08	6.42E-10	1	4.50E-06	9.78E-07	6.42E-10	9.78E-07
Trans-1,2-Dichloroethene	0.045	1.71E-03	1	7.68E-05	0.7	NA	NC	NA	NA	1	9.11E-06	1.30E-05	NA	1.30E-05
Trichloroethane, 1,1,1-	0.045	1.29E-03	1	5.80E-05	5.2	NA	NC	NA	NA	1	6.88E-06	1.32E-06	NA	1.32E-06
Trichloroethene	0.045	1.14E-03	1	5.13E-05	0.18	0.0000017	1	8.70E-08	1.48E-10	1	6.09E-06	3.38E-05	1.48E-10	3.38E-05
Vinyl chloride	0.045	4.71E-03	1	2.12E-04	0.1	0.0000088	1	3.60E-07	3.17E-09	1	2.52E-05	2.52E-04	3.17E-09	2.52E-04
Total									7.66E-09			5.84E-04	7.66E-09	5.84E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-64
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at Alston St.
Excavation Air
Volatilization from Groundwater

Receptor:	Construction Worker	▼
Medium of Origin:	Groundwater	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC (mg/L)	VF Volatilization from Excavation Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	5.00E-04	3.91E-02	1	1.95E-05	0.43	0.000015	1	3.31E-08	4.97E-10	1	2.32E-06	5.39E-06	4.97E-10	5.39E-06
Chloroethane	1.00E-03	1.10E-01	1	1.10E-04	10	NA	NC	NA	NA	1	1.31E-05	1.31E-06	NA	1.31E-06
Chloroform	5.00E-04	7.13E-03	1	3.56E-06	0.66	0.000023	1	6.04E-09	1.39E-10	1	4.23E-07	6.41E-07	1.39E-10	6.41E-07
Dichloroethane, 1,1-	5.00E-04	7.86E-03	1	3.93E-06	5	NA	NC	NA	NA	1	4.66E-07	9.33E-08	NA	9.33E-08
Dichloroethane, cis-1,2-	5.00E-04	5.52E-03	1	2.76E-06	0.035	NA	NC	NA	NA	1	3.28E-07	9.36E-06	NA	9.36E-06
Dichloroethane, 1,1,1-	5.00E-04	4.86E-02	1	2.43E-05	0.2	NA	1	NA	NA	1	2.89E-06	1.44E-05	NA	1.44E-05
Tetrachloroethene	5.28E-04	1.99E-02	1	1.05E-05	4.6	0.00001	1	1.78E-08	1.78E-10	1	1.25E-06	2.71E-07	1.78E-10	2.71E-07
Trans-1,2-Dichloroethene	5.00E-04	1.28E-02	1	6.42E-06	0.7	NA	NC	NA	NA	1	7.63E-07	1.09E-06	NA	1.09E-06
Trichloroethane, 1,1,1-	5.00E-04	2.43E-02	1	1.21E-05	5.2	NA	NC	NA	NA	1	1.44E-06	2.77E-07	NA	2.77E-07
Trichloroethene	1.95E-03	1.33E-02	1	2.59E-05	0.18	0.000017	1	4.39E-08	7.46E-11	1	3.07E-06	1.71E-05	7.46E-11	1.71E-05
Vinyl chloride	5.00E-04	6.91E-02	1	3.45E-05	0.1	0.000088	1	5.86E-08	5.15E-10	1	4.10E-06	4.10E-05	5.15E-10	4.10E-05
Total									1.40E-09			9.09E-05	1.40E-09	9.09E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-65

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Construction Worker at Alston St.
 Excavation Air

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Receptor:	Construction Worker	▼
Medium of Origin:		▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼
		All 3 media

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	2.96E-05	0.43	0.000015	1	5.01E-08	7.52E-10	1	3.51E-06	8.16E-06	7.52E-10	8.16E-06
Chloroethane	2.49E-04	10	NA	NC	NA	NA	1	2.96E-05	2.96E-06	NA	2.96E-06
Chloroform	2.68E-05	0.66	0.000023	1	4.55E-08	1.05E-09	1	3.19E-06	4.83E-06	1.05E-09	4.83E-06
Dichloroethane, 1,1-	1.87E-05	5	NA	NC	NA	NA	1	2.21E-06	4.43E-07	NA	4.43E-07
Dichloroethane, cis-1,2-	1.86E-05	0.035	NA	NC	NA	NA	1	2.20E-06	6.30E-05	NA	6.30E-05
Dichloroethane, 1,1-	4.57E-05	0.2	NA	1	NA	NA	1	5.43E-06	2.71E-05	NA	2.71E-05
Tetrachloroethene	1.68E-05	4.6	0.00001	1	2.84E-08	2.84E-10	1	1.99E-06	4.33E-07	2.84E-10	4.33E-07
Trans-1,2-Dichloroethene	2.78E-05	0.7	NA	NC	NA	NA	1	3.29E-06	4.71E-06	NA	4.71E-06
Trichloroethane, 1,1,1-	2.34E-05	5.2	NA	NC	NA	NA	1	2.78E-06	5.35E-07	NA	5.35E-07
Trichloroethene	2.58E-05	0.18	0.000017	1	4.38E-08	7.44E-11	1	3.06E-06	1.70E-05	7.44E-11	1.70E-05
Vinyl chloride	8.22E-05	0.1	0.0000088	1	1.39E-07	1.23E-09	1	9.76E-06	9.76E-05	1.23E-09	9.76E-05
Total						3.38E-09			2.27E-04	3.38E-09	2.27E-04

NA - Not available

NC - Not calculated

ND - Not detected

Assumes groundwater is directly beneath the excavation

Table A-66
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
Unifirst
Current Resident along Tufts St.
Soil

Receptor:	Resident
Medium:	Soil
Exposure Area:	Current
Depth:	0-3 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-cf	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPc	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der-inc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{os} \times EF}{AP}$$

$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{ds} \times EF}{AP}$$

$$HI_{ing} = \frac{ADD_{ing-inc}}{RfD}$$

$$HI_{der} = \frac{ADD_{der-inc}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing-c} \times CSF$$

$$Risk_{der} = ADD_{der-c} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil) YC-OC-A	HI (Soil) YC
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hiling		
Carbon tetrachloride	0.08	0.0007	0.13	1	2.99E-08	3.88E-09	1	1.93E-07	2.76E-04	7.91E-09	5.11E-04
Chloroethane	0.2	0.4	NA	NC	NA	NA	1	4.83E-07	1.21E-06	NA	2.24E-06
Chloroform	NA	0.01	NA	NA	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.085	0.1	NA	1.3	2.67E-07	2.67E-06	1	2.67E-07	2.67E-06	NA	4.94E-06
Dichloroethene, cis-1,2-	0.085	0.01	NA	1	2.05E-07	2.05E-05	1	2.05E-07	1.75E-05	NA	3.80E-05
Dichloroethene, 1,1-	0.085	0.05	NA	NC	NA	NA	1	2.05E-07	4.11E-06	NA	7.61E-06
Tetrachloroethene	0.0994	0.01	0.051	1	3.71E-08	1.89E-09	1	2.40E-07	2.40E-05	3.85E-09	4.45E-05
Trans-1,2-Dichloroethene	0.08	0.02	NA	NC	NA	NA	1	1.93E-07	9.67E-06	NA	1.79E-05
Trichloroethane, 1,1,1-	0.085	0.09	NA	1	2.99E-08	3.28E-10	1	2.05E-07	2.28E-06	NA	4.23E-06
Trichloroethene	0.08	0.002	0.011	1	2.99E-08	6.40E-08	1	1.93E-07	9.67E-05	6.69E-10	1.79E-04
Vinyl chloride	0.08	0.003	1.4	1.53	4.57E-08	7.01E-08	1	1.93E-07	6.45E-05	1.33E-07	1.19E-04
Total										1.46E-07	9.29E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-67
Exposure and Risk Estimates Associated With Inhalation of Soil-Derives Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Current Resident along Tufts St
Ambient Air

Receptor	Resident	▼
Medium of Origin	Soil	▼
Exposure Medium	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	0-3 feet	▼
Duration	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRair TWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh-gi-nr} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{nr} \times ET \times EF \times C}{AP}$$
$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh-nr} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{nr} \times ET \times EF \times C}{AP}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gi-nr}}{RfD} + \frac{ADE_{inh-nr}}{RfC}$$
$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-nhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinc	ADD-inhnc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.08	2.56E-09	0.43	0.000015	0.0007	0.13	1	3.596E-11	1.259E-10	1.89E-12	1.438E-10	1.87E-11	1	8.91E-11	3.12E-10	7.25E-10	2.67E-10	3.82E-07	2.06E-11	3.83E-07
Chloroethene	0.2	6.40E-09	1.0	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	2.23E-10	7.80E-10	7.80E-11	6.68E-10	1.67E-09	NA	1.75E-09
Chloroform	NA	NA	0.66	0.000023	0.01	NA	1	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Dichloroethene, 1,1-	0.085	2.72E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	9.47E-11	3.31E-10	6.63E-10	2.84E-10	2.84E-09	NA	3.50E-09
Dichloroethene, cis-1,2-	0.085	2.72E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	9.47E-11	3.31E-10	9.47E-09	2.84E-10	2.84E-08	NA	3.79E-08
Tetrachloroethene, 1,1-	0.085	2.72E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	9.47E-11	3.31E-10	1.66E-09	2.84E-10	5.68E-09	NA	7.34E-09
Trans-1,2-Dichloroethene	0.0994	3.18E-09	4.6	0.00001	0.01	0.051	1	4.468E-11	1.564E-10	1.56E-12	1.787E-10	9.11E-12	1	1.11E-10	3.88E-10	8.42E-11	3.32E-10	3.32E-08	1.07E-11	3.33E-08
Trichloroethene, 1,1,1-	0.08	2.56E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	8.91E-11	3.12E-10	4.46E-09	2.67E-10	1.34E-08	NA	1.78E-08
Trichloroethene	0.085	2.72E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	9.47E-11	3.31E-10	6.37E-11	2.84E-10	3.16E-09	NA	3.22E-09
Vinyl chloride	0.08	2.56E-09	0.18	0.0000017	0.002	0.011	1	3.596E-11	1.259E-10	2.14E-13	1.438E-10	1.58E-12	1	8.91E-11	3.12E-10	1.73E-09	2.67E-10	1.34E-07	1.80E-12	1.35E-07
		2.56E-09	0.1	0.0000088	0.003	1.4	1	3.596E-11	1.259E-10	1.11E-12	1.438E-10	2.01E-10	1	8.91E-11	3.12E-10	3.12E-09	2.67E-10	8.91E-08	2.02E-10	9.22E-08
Total										4.77E-12		2.31E-10				2.20E-08		6.93E-07	2.36E-10	7.15E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-68
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Resident along Tufts St.
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$
$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinh	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	5.55E-05	1.11E-04	NA	1.11E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	5.41E-05	1.55E-03	NA	1.55E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	5.41E-05	2.71E-04	NA	2.71E-04
Tetrachloroethene	3.53E-03	4.6	0.00001	1	2.07E-04	2.07E-06	1	4.84E-04	1.05E-04	2.07E-06	1.05E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	5.41E-05	7.73E-04	NA	7.73E-04
Trichloroethane, 1,1,1-	7.41E-04	5.2	NA	NC	NA	NA	1	1.01E-04	1.95E-05	NA	1.95E-05
Trichloroethene	6.30E-04	0.18	0.0000017	1	3.70E-05	6.28E-08	1	8.63E-05	4.79E-04	6.28E-08	4.79E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.50E-05	1.32E-07	1	3.49E-05	3.49E-04	1.32E-07	3.49E-04
Total						2.27E-06			3.65E-03	2.27E-06	3.65E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-69
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Resident along Tufts St.
Soil

Receptor:
Medium:
Exposure Area:
Depth:
Duration:

Resident
Soil
Future
0-15 feet
Chronic

▼
▼
▼
▼
▼

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm2/d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-c1	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPc	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{oc} \times EF \times EP}{AP \times BW}$$

$$ADD_{der-nc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{oc} \times EF \times EP}{AP \times BW}$$

$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{oc} \times EF}{AP}$$

$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{oc} \times EF}{AP}$$

$$HI_{ing} = \frac{ADD_{ing-nc}}{RfD}$$

$$HI_{der} = \frac{ADD_{der-nc}}{RfD}$$

$$III = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing-c} \times CS^*$$

$$Risk_{der} = ADD_{der-c} \times CS^*$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total							
				RAFOsc	ADDIng-c mg/kg-d	RiskIng	RAFOsnc	ADDIng-nc mg/kg-d	HIIng	RAFDsc	ADDder-c mg/kg-d	Riskder	RAFDsnc	ADDder-nc mg/kg-d	HIder	Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.0278	0.0007	0.13	1	1.04E-08	1.35E-09	1	6.72E-08	9.60E-05	0.1	1.08E-08	1.40E-09	0.1	5.72E-08	8.17E-05	2.75E-09	1.78E-04
Chloroethane	0.0555	0.4	NA	NC	NA	NA	1	1.34E-07	3.35E-07	NC	NA	NA	0.1	1.14E-07	2.85E-07	NA	6.21E-07
Chloroform	0.0278	0.01	NA	NA	NA	NA	1	6.72E-08	6.72E-06	NA	NA	NA	0.1	5.72E-08	5.72E-06	NA	1.24E-05
Dichloroethane, 1,1-	0.0278	0.1	NA	NC	NA	NA	1.3	8.74E-08	8.74E-07	NC	NA	NA	0.13	7.43E-08	7.43E-07	NA	1.62E-06
Dichloroethene, cis-1,2-	0.0278	0.01	NA	NC	NA	NA	1	6.72E-08	6.72E-06	NC	NA	NA	0.1	5.72E-08	5.72E-06	NA	1.24E-05
Dichloroethene, 1,1-	0.0278	0.05	NA	NC	NA	NA	1	6.72E-08	1.34E-06	NC	NA	NA	0.1	5.72E-08	1.14E-06	NA	2.49E-06
Tetrachloroethene	0.324	0.01	0.051	1	1.21E-07	6.17E-09	1	7.83E-07	7.83E-05	0.1	1.25E-07	6.40E-09	0.1	6.66E-07	6.66E-05	1.26E-08	1.45E-04
Trans-1,2-Dichloroethene	0.0278	0.02	NA	NC	NA	NA	1	6.72E-08	3.36E-06	NC	NA	NA	0.1	5.72E-08	2.86E-06	NA	6.22E-06
Trichloroethane, 1,1,1-	0.0795	0.09	NA	NC	NA	NA	1	1.92E-07	2.14E-06	NC	NA	NA	0.1	1.64E-07	1.82E-06	NA	3.95E-06
Trichloroethene	0.0278	0.002	0.011	1	1.04E-08	1.14E-10	1	6.72E-08	3.36E-05	0.1	1.08E-08	1.18E-10	0.1	5.72E-08	2.86E-05	2.33E-10	6.22E-05
Vinyl chloride	0.0278	0.003	1.4	1.53	1.59E-08	2.22E-08	1	6.72E-08	2.24E-05	0.16	1.72E-08	2.41E-08	0.1	5.72E-08	1.91E-05	4.63E-08	4.15E-05
Total						2.99E-08			2.52E-04			3.20E-08			2.14E-04	6.19E-08	4.66E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-70
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
UnFirst
Future Resident along Tufts St
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m³/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m³-y/h-kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m³	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{airTWA} \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{airTWA} \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$

$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m³)	RIC (mg/m³)	URF 1/(ug/m³)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFIc	ADD-inhc mg/kg-d	ADE-c mg/m³	Riskinh	ADD-ingc	Risking	RAFInc	ADD-inhnc mg/kg-d	ADE-nc mg/m³	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0278	8.90E-10	0.43	0.000015	0.0007	0.13	1	1.25E-11	4.373E-11	6.56E-13	4.998E-11	6.50E-12	1	3.10E-11	1.08E-10	2.52E-10	9.29E-11	1.33E-07	7.15E-12	1.33E-07
Chloroethane	0.0555	1.78E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	6.18E-11	2.16E-10	2.16E-11	1.85E-10	4.64E-10	NA	4.85E-10
Chloroform	0.0278	8.90E-10	0.66	0.000023	0.01	NA	1	1.25E-11	4.373E-11	1.01E-12	NA	NA	1	3.10E-11	1.08E-10	1.64E-10	9.29E-11	9.29E-09	1.01E-12	9.45E-09
Dichloroethane, 1,1-	0.0278	8.90E-10	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	3.10E-11	1.08E-10	2.17E-10	9.29E-11	9.29E-10	NA	1.15E-09
Dichloroethane, cis-1,2-	0.0278	8.90E-10	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	3.10E-11	1.08E-10	3.10E-09	9.29E-11	9.29E-09	NA	1.24E-08
Dichloroethane, 1,1,1-	0.0278	8.90E-10	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	3.10E-11	1.08E-10	5.42E-10	9.29E-11	1.86E-09	NA	2.40E-09
Tetrachloroethene	0.324	1.04E-08	4.6	0.00001	0.01	0.051	1	1.456E-10	5.097E-10	5.10E-12	5.825E-10	2.97E-11	1	3.61E-10	1.26E-09	2.75E-10	1.08E-09	1.08E-07	3.48E-11	1.09E-07
Trans-1,2-Dichloroethene	0.0278	8.90E-10	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	3.10E-11	1.08E-10	1.55E-09	9.29E-11	4.65E-09	NA	6.19E-09
Trichloroethane, 1,1,1-	0.0795	2.54E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	8.86E-11	3.10E-10	5.96E-11	2.66E-10	2.95E-09	NA	3.01E-09
Trichloroethene	0.0278	8.90E-10	0.18	0.0000017	0.002	0.011	1	1.25E-11	4.373E-11	7.44E-14	4.998E-11	5.50E-13	1	3.10E-11	1.08E-10	6.02E-10	9.29E-11	4.65E-08	6.24E-13	4.71E-08
Vinyl chloride	0.0278	8.90E-10	0.1	0.0000088	0.003	1.4	1	1.25E-11	4.373E-11	3.85E-13	4.998E-11	7.00E-11	1	3.10E-11	1.08E-10	1.08E-10	9.29E-11	3.10E-08	7.04E-11	3.21E-08
Total										7.22E-12		1.07E-10				7.86E-09		3.48E-07	1.14E-10	3.56E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-71
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Resident along Tufts St.
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air Data Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	5.55E-05	1.11E-04	NA	1.11E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	5.41E-05	1.55E-03	NA	1.55E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	5.41E-05	2.71E-04	NA	2.71E-04
Tetrachloroethene	3.53E-03	4.6	0.00001	1	2.07E-04	2.07E-06	1	4.84E-04	1.05E-04	2.07E-06	1.05E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	5.41E-05	7.73E-04	NA	7.73E-04
Trichloroethane, 1,1,1-	7.41E-04	5.2	NA	NC	NA	NA	1	1.01E-04	1.95E-05	NA	1.95E-05
Trichloroethene	6.30E-04	0.18	0.0000017	1	3.70E-05	6.28E-08	1	8.63E-05	4.79E-04	6.28E-08	4.79E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.50E-05	1.32E-07	1	3.49E-05	3.49E-04	1.32E-07	3.49E-04
Total						2.27E-06			3.65E-03	2.27E-06	3.65E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-72
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker along Tufts St.
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IR _{soil}	Soil Ingestion Rate	mg/d	50	
IR _{soil} TWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-ci	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPC	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{R/D}$$

$$HI_{der} = \frac{ADD_{der}}{R/D}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFOsc	ADD _{ing} -c mg/kg-d	Risk _{ing}	RAFOsnc	ADD _{ing} -nc mg/kg-d	Hiling	Dermal Contact RAFDsc	ADD _{der} -c mg/kg-d	Risk _{der}	RAFDsnc	ADD _{der} -nc mg/kg-d	Hider	Total Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.0278	0.0007	0.13	1	2.88E-09	3.75E-10	1	7.48E-09	1.07E-05	0.1	6.01E-10	7.81E-11	0.1	1.56E-09	2.23E-06	4.53E-10	1.29E-05
Chloroethane	0.0555	0.4	NA	NC	NA	NA	1	1.49E-08	3.73E-08	NC	NA	NA	0.1	3.11E-09	7.78E-09	NA	4.51E-08
Chloroform	0.0278	0.01	NA	NA	NA	NA	1	7.48E-09	7.48E-07	NA	NA	NA	0.1	1.56E-09	1.56E-07	NA	9.04E-07
Dichloroethane, 1,1-	0.0278	0.1	NA	NC	NA	NA	1.3	9.72E-09	9.72E-08	NC	NA	NA	0.13	2.03E-09	2.03E-08	NA	1.17E-07
Dichloroethane, cis-1,2-	0.0278	0.01	NA	NC	NA	NA	1	7.48E-09	7.48E-07	NC	NA	NA	0.1	1.56E-09	1.56E-07	NA	9.04E-07
Dichloroethane, 1,1-	0.0278	0.05	NA	NC	NA	NA	1	7.48E-09	1.50E-07	NC	NA	NA	0.1	1.56E-09	3.12E-08	NA	1.81E-07
Tetrachloroethene	0.324	0.01	0.051	1	3.36E-08	1.71E-09	1	8.72E-08	8.72E-06	0.1	7.01E-09	3.57E-10	0.1	1.82E-08	1.82E-06	2.07E-09	1.05E-05
Trans-1,2-Dichloroethene	0.0278	0.02	NA	NC	NA	NA	1	7.48E-09	3.74E-07	NC	NA	NA	0.1	1.56E-09	7.79E-08	NA	4.52E-07
Trichloroethane, 1,1,1-	0.0795	0.09	NA	NC	NA	NA	1	2.14E-08	2.38E-07	NC	NA	NA	0.1	4.46E-09	4.95E-08	NA	2.87E-07
Trichloroethene	0.0278	0.002	0.011	1	2.88E-09	3.17E-11	1	7.48E-09	3.74E-06	0.1	6.01E-10	6.61E-12	0.1	1.56E-09	7.79E-07	3.83E-11	4.52E-06
Vinyl chloride	0.0278	0.003	1.4	1.53	4.41E-09	6.18E-09	1	7.48E-09	2.49E-06	0.16	9.62E-10	1.35E-09	0.1	1.56E-09	5.20E-07	7.53E-09	3.01E-06
Total						8.30E-09			2.80E-05			1.79E-09			5.84E-06	1.01E-08	3.39E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A.73
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
UnFirst
Future Commercial Worker along Tufts St.
Ambient Air

Receptor	Commercial/Industrial Worker	▼
Medium of Origin	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gt} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$IHL = \frac{ADD_{inh-gt}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gt} \times CSF) + (ADE_{inh} \times URF \times C)$$

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IRair TWA	Outdoor Air TWA Inhalation Rate - Particulates	m3/y-h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	dy	120	
EP	Outdoor Air Exposure Period - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	RAFiC	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFiC	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlrih	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0278	8.90E-10	0.43	0.000015	0.0007	0.13	1	8.862E-12	3.102E-11	4.65E-13	2.659E-11	3.46E-12	1	2.30E-11	8.04E-11	1.87E-10	6.89E-11	9.85E-08	3.92E-12	9.87E-08
Chloroethane	0.0555	1.78E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	4.59E-11	1.61E-10	1.61E-11	1.38E-10	3.44E-10	NA	3.60E-10
Chloroform	0.0278	8.90E-10	0.66	0.000023	0.01	NA	1	8.862E-12	3.102E-11	7.13E-13	NA	NA	1	2.30E-11	8.04E-11	1.22E-10	6.89E-11	7.13E-13	7.13E-13	7.01E-09
Dichloroethane, 1,1-	0.0278	8.90E-10	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	2.30E-11	8.04E-11	1.61E-10	6.89E-11	8.50E-10	NA	8.50E-10
Dichloroethane, cis-1,2-	0.0278	8.90E-10	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	2.30E-11	8.04E-11	2.30E-09	6.89E-11	6.89E-09	NA	9.19E-09
Dichloroethene, 1,1-	0.0278	8.90E-10	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	2.30E-11	8.04E-11	4.02E-10	6.89E-11	1.38E-09	NA	1.78E-09
Tetrachloroethene	0.324	1.04E-08	4.6	0.00001	0.01	0.051	1	1.033E-10	3.615E-10	3.62E-12	3.099E-10	1.58E-11	1	2.88E-10	9.37E-10	2.04E-10	8.03E-10	1.94E-11	8.03E-08	8.03E-08
Trans-1,2-Dichloroethene	0.0278	8.90E-10	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	2.30E-11	8.04E-11	1.15E-09	6.89E-11	3.45E-09	NA	4.60E-09
Trichloroethane, 1,1,1-	0.0795	2.54E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	6.57E-11	2.30E-10	4.42E-11	1.97E-10	2.19E-09	NA	2.29E-09
Trichloroethene	0.0278	8.90E-10	0.18	0.0000017	0.002	0.011	1	8.862E-12	3.102E-11	5.27E-14	2.659E-11	2.92E-13	1	2.30E-11	8.04E-11	4.47E-10	6.89E-11	3.45E-08	3.45E-13	3.49E-08
Vinyl chloride	0.0278	8.90E-10	0.1	0.0000088	0.003	1.4	1	8.862E-12	3.102E-11	2.73E-13	2.659E-11	3.72E-11	1	2.30E-11	8.04E-11	8.04E-10	6.89E-11	2.30E-08	3.75E-11	2.38E-08
Total										5.12E-12		5.68E-11				5.83E-09		2.58E-07	6.19E-11	2.64E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-74
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker along Tufts St.
Ambient Air

Receptor:	Commercial/Industrial Worker	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air data	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.44E-05	8.88E-05	NA	8.88E-05
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	4.33E-05	1.24E-03	NA	1.24E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	4.33E-05	2.16E-04	NA	2.16E-04
Tetrachloroethene	3.53E-03	4.6	0.00001	1	1.49E-04	1.49E-06	1	3.87E-04	8.42E-05	1.49E-06	8.42E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	4.33E-05	6.18E-04	NA	6.18E-04
Trichloroethane, 1,1,1-	7.41E-04	5.2	NA	NC	NA	NA	1	8.12E-05	1.56E-05	NA	1.56E-05
Trichloroethene	6.30E-04	0.18	0.0000017	1	2.66E-05	4.52E-08	1	6.90E-05	3.83E-04	4.52E-08	3.83E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.08E-05	9.49E-08	1	2.79E-05	2.79E-04	9.49E-08	2.79E-04
Total						1.63E-06			2.92E-03	1.63E-06	2.92E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-75
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
Unifirst
Construction Worker along Tufts St.
Soil - Dermal contact & Incidental Ingestion

Receptor:	Construction Worker
Medium:	Surface Soil
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IR _{soil}	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.29	
EF	Soil Exposure Frequency	d/y	130	
EP	Soil Exposure Period - Cancer	y	1	
EP	Soil Exposure Period - Non-Cancer	y	1	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	182	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{soil} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{der} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil)	HI (Soil)
				RAF _{osc}	ADD _{ing-c} mg/kg-d	Risk _{ing}	RAF _{oscnc}	ADD _{ing-nc} mg/kg-d	H _{ling}		
Carbon tetrachloride	0.0278	0.007	0.13	1	2.44E-10	3.17E-11	1	3.42E-08	4.89E-06	6.36E-11	9.82E-06
Chloroethane	0.0555	0.4	NA	NC	NA	NA	1	6.83E-08	1.71E-07	NA	3.43E-07
Chloroform	0.0278	0.01	NA	NC	NA	NA	1	3.42E-08	3.42E-06	NA	6.87E-06
Dichloroethane, 1,1-	0.0278	1	NA	NC	NA	NA	1.3	4.45E-08	4.45E-08	NA	8.93E-08
Dichloroethane, cis-1,2-	0.0278	0.1	NA	NC	NA	NA	1	3.42E-08	3.42E-07	NA	6.87E-07
Dichloroethane, 1,1-	0.0278	0.05	NA	NC	NA	NA	1	3.42E-08	6.85E-07	NA	1.37E-06
Tetrachloroethene	0.324	0.1	0.051	1	2.84E-09	1.45E-10	1	3.99E-07	3.99E-06	2.91E-10	8.01E-06
Trans-1,2-Dichloroethene	0.0278	0.2	NA	NC	NA	NA	1	3.42E-08	1.71E-07	NA	3.44E-07
Trichloroethane, 1,1,1-	0.0795	0.9	NA	NC	NA	NA	1	9.79E-08	1.09E-07	NA	2.18E-07
Trichloroethene	0.0278	0.02	0.011	1	2.44E-10	2.68E-12	1	3.42E-08	1.71E-06	5.38E-12	3.44E-06
Vinyl chloride	0.0278	0.003	1.4	1.53	3.73E-10	5.22E-10	1	3.42E-08	1.14E-05	1.07E-09	2.29E-05
Total						7.02E-10			2.70E-05	1.43E-09	5.41E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-76
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Construction Worker along Tufts St.
Ambient Air

Receptor:	Construction Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	130	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	182	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC	Soil (mg/kg)	EPC	Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inh-c mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ing-c	Risking	RAFinc	ADD-inhnc mg/kg-d	ADE-nc mg/m3	HIinh	ADD-ingnc	HIing	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride		2.78E-02		1.67E-09	0.43	0.000015	0.007	0.13	1	2.107E-12	7.375E-12	1.11E-13	6.321E-12	8.22E-13	1	2.96E-10	1.04E-09	2.41E-09	8.87E-10	1.27E-07	9.32E-13	1.29E-07
Chloroethane		5.55E-02		3.33E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	5.91E-10	2.07E-09	2.07E-10	1.77E-09	4.43E-09	NA	4.64E-09
Chloroform		2.78E-02		1.67E-09	0.66	0.000023	0.01	NA	1	2.107E-12	7.375E-12	1.70E-13	NA	NA	1	2.96E-10	1.04E-09	1.57E-09	8.87E-10	8.87E-08	1.70E-13	9.03E-08
Dichloroethane, 1,1-		2.78E-02		1.67E-09	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	2.96E-10	1.04E-09	2.07E-10	8.87E-10	8.87E-10	NA	1.09E-09
Dichloroethane, cis-1,2-		2.78E-02		1.67E-09	0.035	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	2.96E-10	1.04E-09	2.96E-08	8.87E-10	8.87E-09	NA	3.88E-08
Dichloroethene, 1,1-		2.78E-02		1.67E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	2.96E-10	1.04E-09	5.18E-09	8.87E-10	1.77E-08	NA	2.29E-08
Tetrachloroethene		3.24E-01		1.94E-08	4.6	0.00001	0.1	0.051	1	2.456E-11	8.595E-11	8.60E-13	7.367E-11	3.76E-12	1	3.45E-09	1.21E-08	2.62E-09	1.03E-07	1.03E-07	4.62E-12	1.06E-07
Trans-1,2-Dichloroethene		2.78E-02		1.67E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	2.96E-10	1.04E-09	1.48E-09	8.87E-10	4.44E-09	NA	5.92E-09
Trichloroethane, 1,1,1-		7.95E-02		4.77E-09	5.2	NA	0.9	NA	NC	NA	NA	NA	NA	NA	1	8.46E-10	2.96E-09	5.69E-10	2.54E-09	2.82E-09	NA	3.38E-09
Trichloroethene		2.78E-02		1.67E-09	0.18	0.0000017	0.02	0.011	1	2.107E-12	7.375E-12	1.25E-14	6.321E-12	6.95E-14	1	2.96E-10	1.04E-09	5.75E-09	8.87E-10	4.44E-08	8.20E-14	5.01E-08
Vinyl chloride		2.78E-02		1.67E-09	0.1	0.0000068	0.003	1.4	1	2.107E-12	7.375E-12	6.49E-14	6.321E-12	8.85E-12	1	2.96E-10	1.04E-09	1.04E-08	8.87E-10	2.96E-07	8.91E-12	3.06E-07
Total												1.22E-12		1.35E-11				5.99E-08		6.98E-07	1.47E-11	7.58E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-77
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Construction Worker along Tufts St.

Construction Worker along I nts St.																	
	Henry's Law Constant at Avg GW Temp (conc/conc) H ⁺ _{TS}	Deff Vadose Zone (Layer A + Layer B)	Deff Total (Layer A + Layer B + Layer C)	Deffcrack (Layer A)	Exponent of Peclet Number	Organic Carbon- Water Partition Coefficient Koc	Volatilization from Subsurface Soil to Excavation Air VF	(mg/m3) / (mg/kg)	Volatilization from Subsurface Soil to Trench Air VF	(mg/m3) / (mg/kg)	Volatilization from Soil Gas to Excavation Air Alpha	(mg/m3 excav) / (mg/m3 SG)	Volatilization from Soil Gas to Trench Air Alpha (mg/m3 trench) / (mg/m3 SG)	Volatilization from Groundwater to Excavation Air VF	(mg/m3) / (mg/L)	Volatilization from Groundwater to Trench Air VF	(mg/m3) / (mg/L)
Compound	(conc/conc)	(cm2/sec)	(cm2/sec)	(cm2/sec)		(cm3/g)											
Carbon tetrachloride	5.88E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	152	1.53E-03	6.95E-03	9.35E-05	6.13E-06	3.91E-02	2.56E-03					
Chloroethane	4.77E-01	5.35E-02	3.80E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.64E-02	3.25E-04	2.13E-05	1.10E-01	7.21E-03					
Chloroform	8.04E-02	2.05E-02	1.46E-02	2.05E-02	1.20E+78	52.5	1.11E-03	5.06E-03	1.25E-04	8.17E-06	7.13E-03	4.67E-04					
Dichloroethane, 1,1-	1.24E-01	1.46E-02	1.04E-02	1.46E-02	2.74E+109	53.4	1.15E-03	5.25E-03	8.89E-05	5.83E-06	7.86E-03	5.15E-04					
Dichloroethene, cis-1,2-	8.79E-02	1.45E-02	1.03E-02	1.45E-02	2.13E+110	35.5	1.17E-03	5.34E-03	8.82E-05	5.78E-06	5.52E-03	3.62E-04					
Dichloroethene, 1,1-	6.34E-01	1.78E-02	1.26E-02	1.78E-02	1.68E+90	65	2.51E-03	1.14E-02	1.08E-04	7.07E-06	4.86E-02	3.18E-03					
Tetrachloroethene	3.24E-01	1.42E-02	1.01E-02	1.42E-02	6.04E+112	265	8.42E-04	3.83E-03	8.63E-05	5.65E-06	1.99E-02	1.30E-03					
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	9.91E-03	1.40E-02	7.16E+114	38	1.71E-03	7.75E-03	8.48E-05	5.55E-06	1.28E-02	8.42E-04					
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	135	1.29E-03	5.85E-03	9.35E-05	6.13E-06	2.43E-02	1.59E-03					
Trichloroethene	1.97E-01	1.56E-02	1.11E-02	1.56E-02	6.13E+102	94.3	1.14E-03	5.18E-03	9.47E-05	6.20E-06	1.33E-02	8.70E-04					
Vinyl chloride	7.65E-01	2.09E-02	1.49E-02	2.09E-02	4.04E+76	18.6	4.71E-03	2.14E-02	1.27E-04	8.32E-06	6.91E-02	4.52E-03					

Table A-78
 Site-specific Parameters for Volatilization Calculations
 50 Tufts Street, Somerville MA
 UnFirst
 Construction Worker along Tufts St.

Symbol	(units)	Parameter	Value	Comment
L_{crack}	(cm)	Thickness of foundation	15.0	
f_{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02	
L_f	(15 or 200 cm)	Depth below grade to bottom of enclosed space / floor	15	Input either 15 or 200
L_{WT}	(cm)	Depth below grade to water table	462.0768	Fl.
T_s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)
L_r	(cm)	Source- building separation	447.0768	
L_b	(cm)	Length of building	961	DEP Default
W_b	(cm)	Width of building	961	DEP Default
H_b	(cm)	Height of building	488	DEP Default
X_{crack}	(cm)	Floor- wall seam perimeter	3844.00	
ER	(1/hr)	Air exchange rate	0.45	DEP Default
$Q_{building}$	(cm³/s)	Bldg. ventilation rate	56334.781	
A_g	(cm²)	Area of enclosed space below grade	923521	
η	(unitless)	Crack- to-total area ratio	0.000416233	
Z_{crack}	(cm)	Crack depth below grade	15.0	
μ_{ts}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414	
L_p	(cm)	Diffusion path length	447.0768	
L_p	(cm)	Convection path length	15	
r_{crack}	(cm)	Crack radius	0.10	DEP Default
ΔP	g/cm-s²	Pressure differential between soil surface and enclosed space	40.00	DEP Default
Q_{soil}	(cm³/s)	Average vapor flow rate into bldg.	9.454788E+01	
A_{crack}	(cm²)	Area of crack	384.4	
R_c	(cal/mol-K)	Gas constant	1.9872	
R	(atm-m³/mol-K)	Universal gas constant	0.00008205	
R_2	(mm³-g-cm³/mol-K)	Universal gas constant	82361	
W_{SA}	(cm)	Width of soil source to ambient air	1524	50 Fl.
t_{SA}	(s)	Averaging time for volatilization from soil to ambient air	15768000	0.5 y
U	(cm/s)	Wind speed	225	
D	(cm)	Mixing height	182.88	6 Fl.
Z_s	(cm)	Depth to soil source	462.0768	15.16 Fl.
Z_{SG}	(cm)	Depth to soil gas source	462.0768	15.16 Fl.
W_E	(cm)	Width of excavation	1524	50 Fl.
L_E	(cm)	Length of excavation	762	25 Fl.
H_E	(cm)	Height of excavation	457.2	15 Fl.
W_{Ec}	(cm)	Width of excavation that is contaminated	1524	50 Fl.
L_{Ec}	(cm)	Length of excavation that is contaminated	762	25 Fl.
H_{Ec}	(cm)	Height of excavation that is contaminated	457.2	15 Fl.
WT	(cm)	Width of trench	457.2	15 Fl.
LT	(cm)	Length of trench	121.92	4 Fl.
HT	(cm)	Height of trench	182.88	6 Fl.
W_{Tc}	(cm)	Width of trench that is contaminated	457.2	15 Fl.
L_{Tc}	(cm)	Length of trench that is contaminated	121.92	4 Fl.
H_{Tc}	(cm)	Height of trench that is contaminated	182.88	6 Fl.
t_{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y
t_{ST}	(s)	Averaging time for volatilization from soil to trench	31536000	1 y
F_E	(unitless)	Fraction of wind speed that occurs in excavation	0.5	
F_T	(unitless)	Fraction of wind speed that occurs in trench	0.1	
d	(cm)	Lower depth of surface soil source	462.0768	15.16 Fl.

Vadose Zone			Capillary Zone		
Layer A	Layer B		Layer A	Layer B	
1.5	1.5		1.5	1.5	
0.43	0.43		0.43	0.43	
0.06	0.06		0.253258113	0.253258113	
0.37	0.37		0.176741887	0.176741887	
15	415.0313455		17.04545455	17.04545455	
			0.018567639	0.018567639	
			9.92425E-08	9.92425E-08	
			0.986637033	0.986637033	
			9.79163E-08	9.79163E-08	

Vadose zone soil dry bulk density		
P_b	n	θ_w
(g/cm³)	(unitless)	(cm³/cm³)
0.43	0.43	0.253258113
		(cm³/cm³)
		0.176741887
		(cm)
		17.04545455
		(cm³/cm³)
		0.018567639
		(cm²)
		9.92425E-08
		(cm²)
		0.986637033
		(cm²)
		9.79163E-08

Select soil type in vadose zone and capillary zone:

Vadose zone adjacent to building Sand

Capillary zone Sand

Key:

Type in Site-specific values here
Calculated values
Constants
Default parameter values from DEP

Values Assume all sources are 1 inch below excavation depth

Table A-79
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
Unifirst
Construction Worker along Tufts St.
Excavation Air
Volatilization from Soil Gas

Receptor:	Construction Worker	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

	EPC	Alpha Volatilization from Soil Gas to Excavation Air	Source Dilution Factor	EPC	RfC	URF	RAFc	ADE-c	Riskinh	RAFinc	ADE-nc	Hlinh	Risk (Trench Air)	HI (Trench Air)
Compound	mg/m3	(mg/m3 excav) / (mg/m3 SG)		(mg/m3)	(mg/m3)	1/(ug/m3)		mg/m3			mg/m3			
Carbon tetrachloride	1.25E-02	9.35E-05	1	1.17E-06	0.43	0.000015	1	1.98E-09	2.97E-11	1	1.39E-07	3.23E-07	2.97E-11	3.23E-07
Chloroethane	5.50E-03	3.25E-04	1	1.79E-06	10	NA	NC	NA	NA	1	2.12E-07	2.12E-08	NA	2.12E-08
Chloroform	NA	1.25E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	8.00E-03	8.89E-05	1	7.12E-07	5	NA	NC	NA	NA	1	8.45E-08	1.69E-08	NA	1.69E-08
Dichloroethene, cis-1,2-	8.00E-03	8.82E-05	1	7.06E-07	0.035	NA	NC	NA	NA	1	8.38E-08	2.39E-06	NA	2.39E-06
Dichloroethene, 1,1-	8.00E-03	1.08E-04	1	8.63E-07	0.2	NA	1	NA	NA	1	1.02E-07	5.12E-07	NA	5.12E-07
Tetrachloroethene	8.85E+00	8.63E-05	1	7.63E-04	4.6	0.00001	1	1.29E-06	1.29E-08	1	9.06E-05	1.97E-05	1.29E-08	1.97E-05
Trans-1,2-Dichloroethene	8.00E-03	8.48E-05	1	6.78E-07	0.7	NA	NC	NA	NA	1	8.05E-08	1.15E-07	NA	1.15E-07
Trichloroethane, 1,1,1-	3.34E-01	9.35E-05	1	3.12E-05	5.2	NA	NC	NA	NA	1	3.71E-06	7.13E-07	NA	7.13E-07
Trichloroethene	3.21E-02	9.47E-05	1	3.04E-06	0.18	0.0000017	1	5.16E-09	8.77E-12	1	3.61E-07	2.01E-06	8.77E-12	2.01E-06
Vinyl chloride	5.00E-03	1.27E-04	1	6.35E-07	0.1	0.0000088	1	1.08E-09	9.48E-12	1	7.54E-08	7.54E-07	9.48E-12	7.54E-07
Total									1.30E-08			2.66E-05	1.30E-08	2.66E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-80
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker along Tufts St.
Excavation Air
Volatilization from Subsurface Soil

Receptor:	Construction Worker	▼
Medium of Origin:	Subsurface Soil	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Subsurface Soil mg/kg	VF Volatilization from Subsurface Soil to Excavation Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.0278	1.53E-03	1	4.25E-05	0.43	0.000015	1	7.21E-08	1.08E-09	1	5.05E-06	1.17E-05	1.08E-09	1.17E-05
Chloroethane	0.0555	5.80E-03	1	3.22E-04	10	NA	NC	NA	NA	1	3.82E-05	3.82E-06	NA	3.82E-06
Chloroform	0.0278	1.11E-03	1	3.09E-05	0.66	0.000023	1	5.25E-08	1.21E-09	1	3.67E-06	5.57E-06	1.21E-09	5.57E-06
Dichloroethane, 1,1-	0.0278	1.15E-03	1	3.21E-05	5	NA	NC	NA	NA	1	3.81E-06	7.62E-07	NA	7.62E-07
Dichloroethane, cis-1,2-	0.0278	1.17E-03	1	3.27E-05	0.035	NA	NC	NA	NA	1	3.88E-06	1.11E-04	NA	1.11E-04
Dichloroethane, 1,1-	0.0278	2.51E-03	1	6.96E-05	0.2	NA	1	NA	NA	1	8.27E-06	4.13E-05	NA	4.13E-05
Tetrachloroethene	0.324	8.42E-04	1	2.73E-04	4.6	0.00001	1	4.63E-07	4.63E-09	1	3.24E-05	7.04E-06	4.63E-09	7.04E-06
Trans-1,2-Dichloroethene	0.0278	1.71E-03	1	4.74E-05	0.7	NA	NC	NA	NA	1	5.63E-06	8.04E-06	NA	8.04E-06
Trichloroethane, 1,1,1-	0.0795	1.29E-03	1	1.02E-04	5.2	NA	NC	NA	NA	1	1.22E-05	2.34E-06	NA	2.34E-06
Trichloroethene	0.0278	1.14E-03	1	3.17E-05	0.18	0.0000017	1	5.37E-08	9.13E-11	1	3.76E-06	2.09E-05	9.13E-11	2.09E-05
Vinyl chloride	0.0278	4.71E-03	1	1.31E-04	0.1	0.0000088	1	2.22E-07	1.96E-09	1	1.56E-05	1.56E-04	1.96E-09	1.56E-04
Total									8.96E-09			3.68E-04	8.96E-09	3.68E-04

NA - Not available
NC - Not calculated
ND - Not detected
juneupdate_construction Tufts Street Area.xls - constructVOLtoEXC(soil)

Table A-81

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Construction Worker along Tufts St.
 Excavation Air
 Volatilization from Groundwater

Receptor:	Construction Worker	▼
Medium of Origin:	Groundwater	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC (mg/L)	VF Volatilization from Groundwater to Excavation Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	5.00E-04	3.91E-02	1	1.95E-05	0.43	0.000015	1	3.31E-08	4.97E-10	1	2.32E-06	5.39E-06	4.97E-10	5.39E-06
Chloroethane	1.00E-03	1.10E-01	1	1.10E-04	10	NA	NC	NA	NA	1	1.31E-05	1.31E-06	NA	1.31E-06
Chloroform	5.00E-04	7.13E-03	1	3.56E-06	0.66	0.000023	1	6.04E-09	1.39E-10	1	4.23E-07	6.41E-07	1.39E-10	6.41E-07
Dichloroethane, 1,1-	1.28E-02	7.86E-03	1	1.00E-04	5	NA	NC	NA	NA	1	1.19E-05	2.38E-06	NA	2.38E-06
Dichloroethene, cis-1,2-	1.28E-02	5.52E-03	1	7.04E-05	0.035	NA	NC	NA	NA	1	8.36E-06	2.39E-04	NA	2.39E-04
Dichloroethene, 1,1-	1.28E-02	4.86E-02	1	6.20E-04	0.2	NA	1	NA	NA	1	7.36E-05	3.68E-04	NA	3.68E-04
Tetrachloroethene	1.25E+01	1.99E-02	1	2.48E-01	4.6	0.00001	1	4.21E-04	4.21E-06	1	2.94E-02	6.40E-03	4.21E-06	6.40E-03
Trans-1,2-Dichloroethene	5.00E-04	1.28E-02	1	6.42E-06	0.7	NA	NC	NA	NA	1	7.63E-07	1.09E-06	NA	1.09E-06
Trichloroethane, 1,1,1-	9.20E-02	2.43E-02	1	2.23E-03	5.2	NA	NC	NA	NA	1	2.65E-04	5.10E-05	NA	5.10E-05
Trichloroethene	1.02E-01	1.33E-02	1	1.35E-03	0.18	0.0000017	1	2.29E-06	3.90E-09	1	1.61E-04	8.92E-04	3.90E-09	8.92E-04
Vinyl chloride	5.00E-04	6.91E-02	1	3.45E-05	0.1	0.0000088	1	5.86E-08	5.15E-10	1	4.10E-06	4.10E-05	5.15E-10	4.10E-05
Total									4.21E-06			8.00E-03	4.21E-06	8.00E-03

NA - Not available
 NC - Not calculated
 ND - Not detected

Table A-82
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker along Tufts St.
Excavation Air

Receptor:	Construction Worker	▼	All 3 media
Medium of Origin:		▼	
Exposure Medium:	Excavation Air	▼	
Exposure Area:	Excavation	▼	
Depth:	0-15 feet	▼	
Duration:	Subchronic	▼	

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	2.11E-05	0.43	0.000015	1	3.58E-08	5.36E-10	1	2.50E-06	5.82E-06	5.36E-10	5.82E-06
Chloroethane	1.45E-04	10	NA	NC	NA	NA	1	1.72E-05	1.72E-06	NA	1.72E-06
Chloroform	1.73E-05	0.66	0.000023	1	2.93E-08	6.73E-10	1	2.05E-06	3.10E-06	6.73E-10	3.10E-06
Dichloroethane, 1,1-	4.43E-05	5	NA	NC	NA	NA	1	5.26E-06	1.05E-06	NA	1.05E-06
Dichloroethane, cis-1,2-	3.46E-05	0.035	NA	NC	NA	NA	1	4.11E-06	1.17E-04	NA	1.17E-04
Dichloroethane, 1,1-	2.30E-04	0.2	NA	1	NA	NA	1	2.73E-05	1.37E-04	NA	1.37E-04
Tetrachloroethene	8.30E-02	4.6	0.00001	1	1.41E-04	1.41E-06	1	9.85E-03	2.14E-03	1.41E-06	2.14E-03
Trans-1,2-Dichloroethene	1.82E-05	0.7	NA	NC	NA	NA	1	2.16E-06	3.08E-06	NA	3.08E-06
Trichloroethane, 1,1,1-	7.89E-04	5.2	NA	NC	NA	NA	1	9.37E-05	1.80E-05	NA	1.80E-05
Trichloroethene	4.62E-04	0.18	0.000017	1	7.84E-07	1.33E-09	1	5.49E-05	3.05E-04	1.33E-09	3.05E-04
Vinyl chloride	5.54E-05	0.1	0.0000088	1	9.39E-08	8.27E-10	1	6.58E-06	6.58E-05	8.27E-10	6.58E-05
Total						1.41E-06			2.80E-03	1.41E-06	2.80E-03

NA - Not available
NC - Not calculated
ND - Not detected
Assumes groundwater is directly beneath the excavation

Table A-84
Exposure and Risk Estimates Associated With Inhalation of Soil-Derives Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Current Resident at other streets
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Current	▼
Depth:	0-3 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h*kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	d	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$

$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFIc	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFInc	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC	
Carbon tetrachloride	0.0485	1.55E-09	0.43	0.000015	0.0007	0.13	1	2.18E-11	7.63E-11	1.14E-12	8.72E-11	1.13E-11	1	5.40E-11	1.89E-10	4.40E-10	1.62E-10	2.32E-07	1.25E-11	2.32E-07	
Chloroethane	0.12	3.84E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	1.34E-10	4.68E-10	4.68E-11	4.01E-10	1.00E-09	NA	1.05E-09	
Chloroform	0.0485	1.55E-09	0.66	0.000023	0.01	NA	1	2.18E-11	7.63E-11	1.75E-12	NA	NA	1	5.40E-11	1.89E-10	2.87E-10	1.62E-10	1.62E-08	1.75E-12	1.65E-08	
Dichloroethane, 1,1-	0.13	4.16E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	1.45E-10	5.07E-10	1.01E-09	4.34E-10	4.34E-09	NA	5.36E-09	
Dichloroethane, cis-1,2-	0.0485	1.55E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	5.40E-11	1.89E-10	5.40E-09	1.62E-10	1.62E-08	NA	2.16E-08	
Dichloroethane, 1,1-	0.0485	1.55E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	5.40E-11	1.89E-10	9.45E-10	1.62E-10	3.24E-09	NA	4.19E-09	
Dichloroethane, 1,1,1-	0.0485	1.55E-09	0.485	0.00001	0.01	0.051	1	4.445E-10	1.556E-09	1.56E-11	1.778E-09	9.07E-11	1	1.10E-09	3.86E-09	8.38E-10	3.31E-09	3.31E-07	1.06E-10	3.31E-07	
Tetrachloroethene	0.989	3.16E-08	4.6	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	5.40E-11	1.89E-10	2.70E-09	1.62E-10	8.10E-09	NA	1.08E-08	
Trans-1,2-Dichloroethene	0.0485	1.55E-09	0.07	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	8.54E-11	2.99E-10	5.75E-11	2.56E-10	2.85E-09	NA	2.91E-09	
Trichloroethane, 1,1,1-	0.0767	2.45E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	3.99E-10	1.40E-09	7.75E-09	1.20E-09	5.98E-07	8.04E-12	6.06E-07	
Trichloroethene	0.358	1.15E-08	0.18	0.0000017	0.002	0.011	1	1.609E-10	5.632E-10	9.57E-13	6.436E-10	7.08E-12	1	3.99E-10	1.40E-09	7.75E-09	1.20E-09	5.98E-07	8.04E-12	6.06E-07	
Vinyl chloride	0.0485	1.55E-09	0.1	0.0000088	0.003	1.4	1	2.18E-11	7.63E-11	6.71E-13	8.72E-11	1.22E-10	1	5.40E-11	1.89E-10	1.89E-09	1.62E-10	5.40E-08	1.23E-10	5.59E-08	
Total										2.01E-11		2.31E-10				2.14E-08		1.27E-06		2.51E-10	1.29E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-85
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Resident at other streets
Ambient Air

Receptor:	Resident
Medium of Origin:	Ambient Air
Exposure Medium:	Ambient Air
Exposure Area:	Current
Depth:	Shallow
Duration:	Chronic

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr \times d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air Data	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.73E-04	0.5	NA	NC	NA	NA	1	6.47E-05	1.29E-04	NA	1.29E-04
Dichloroethane, cis-1,2-	4.61E-04	0.035	NA	NC	NA	NA	1	6.31E-05	1.80E-03	NA	1.80E-03
Dichloroethane, 1,1-	4.61E-04	0.2	NA	1	NA	NA	1	6.31E-05	3.16E-04	NA	3.16E-04
Tetrachloroethene	8.17E-04	4.6	0.00001	1	4.79E-05	4.79E-07	1	1.12E-04	2.43E-05	4.79E-07	2.43E-05
Trans-1,2-Dichloroethene	4.61E-04	0.07	NA	NC	NA	NA	1	6.31E-05	9.02E-04	NA	9.02E-04
Trichloroethane, 1,1,1-	6.42E-04	5.2	NA	NC	NA	NA	1	8.79E-05	1.69E-05	NA	1.69E-05
Trichloroethene	6.42E-04	0.18	0.0000017	1	3.77E-05	6.40E-08	1	8.79E-05	4.88E-04	6.40E-08	4.88E-04
Vinyl chloride	2.98E-04	0.1	0.0000088	1	1.75E-05	1.54E-07	1	4.08E-05	4.08E-04	1.54E-07	4.08E-04
Total						6.97E-07			4.09E-03	6.97E-07	4.09E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-86
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Commercial Worker at other streets
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	50	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-c	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPc	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF'_{ox} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF'_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF'$$

$$Risk_{der} = ADD_{der} \times CSF'$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total							
				RAFosc	ADDing-c mg/kg-d	Risking	RAFsosc	ADDing-nc mg/kg-d	Hling	RAFdsc	ADDder-c mg/kg-d	Riskder	RAFsdc	ADDder-nc mg/kg-d	Hlder	Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.0485	0.0007	0.13	1	5.03E-09	6.54E-10	1	1.30E-08	1.86E-05	0.1	1.05E-09	1.36E-10	0.1	2.72E-09	3.88E-06	7.91E-10	2.25E-05
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	3.23E-08	8.07E-08	NC	NA	NA	0.1	6.73E-09	1.68E-08	NA	9.75E-08
Chloroform	0.0485	0.01	NA	NA	NA	NA	1	1.30E-08	1.30E-06	NA	NA	NA	0.1	2.72E-09	2.72E-07	NA	1.58E-06
Dichloroethane, 1,1-	0.13	0.1	NA	NC	NA	NA	1.3	4.55E-08	4.55E-07	NC	NA	NA	0.13	9.47E-09	9.47E-08	NA	5.49E-07
Dichloroethene, cis-1,2-	0.0485	0.01	NA	NC	NA	NA	1	1.30E-08	1.30E-06	NC	NA	NA	0.1	2.72E-09	2.72E-07	NA	1.58E-06
Dichloroethene, 1,1-	0.0485	0.05	NA	NC	NA	NA	1	1.30E-08	2.61E-07	NC	NA	NA	0.1	2.72E-09	5.44E-08	NA	3.15E-07
Tetrachloroethene	0.989	0.01	0.051	1	1.03E-07	5.23E-09	1	2.66E-07	2.66E-05	0.1	2.14E-08	1.09E-09	0.1	5.54E-08	5.54E-06	6.32E-09	3.22E-05
Trans-1,2-Dichloroethene	0.0485	0.02	NA	NC	NA	NA	1	1.30E-08	6.52E-07	NC	NA	NA	0.1	2.72E-09	1.36E-07	NA	7.88E-07
Trichloroethane, 1,1,1-	0.0767	0.09	NA	NC	NA	NA	1	2.06E-08	2.29E-07	NC	NA	NA	0.1	4.30E-09	4.78E-08	NA	2.77E-07
Trichloroethene	0.358	0.002	0.011	1	3.72E-08	4.09E-10	1	9.63E-08	4.82E-05	0.1	7.74E-09	8.52E-11	0.1	2.01E-08	1.00E-05	4.94E-10	5.82E-05
Vinyl chloride	0.0485	0.003	1.4	1.53	7.70E-09	1.08E-08	1	1.30E-08	4.35E-06	0.16	1.68E-09	2.35E-09	0.1	2.72E-09	9.06E-07	1.31E-08	5.26E-06
Total						1.71E-08			1.02E-04			3.66E-09			2.13E-05	2.07E-08	1.23E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-87
Exposure end Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
UnitFirst
Commercial Worker at other streets
Ambient Air

Receptor:	Commercial/Industrial Worker	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	120	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	27	
ATC	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gt-e} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gt-ne} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-e} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-ne} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70 \text{ kg}}{20 \text{ m}^3 \text{ I d}}$$

$$HI = \frac{ADD_{inh-gt-ne}}{RfD} + \frac{ADE_{inh-ne}}{RfC}$$

$$Risk = (ADD_{inh-gt-e} \times CSF) + (ADE_{inh-e} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFIc	ADD-inh mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ings	Risking	RAFInc	ADD-inhnc mg/kg-d	ADE-ne mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.0485	1.55E-09	0.43	0.000015	0.0007	0.13	1	1.546E-11	5.411E-11	8.12E-13	4.638E-11	6.03E-12	1	4.01E-11	1.40E-10	3.26E-10	1.20E-10	1.72E-07	6.84E-12	1.72E-07
Chloroethane	0.12	3.84E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	9.92E-11	3.47E-10	3.47E-11	2.98E-10	7.44E-10	NA	7.79E-10
Chloroform	0.0485	1.55E-09	0.66	0.000023	0.01	NA	1	1.546E-11	5.411E-11	1.24E-12	NA	NA	1	4.01E-11	1.40E-10	2.13E-10	1.20E-10	1.20E-08	1.24E-12	1.22E-08
Dichloroethane, 1,1-	0.13	4.16E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	1.07E-10	3.76E-10	7.52E-10	3.22E-09	3.22E-09	NA	3.98E-09
Dichloroethane, cis-1,2-	0.0485	1.55E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	4.01E-11	1.40E-10	4.01E-09	1.20E-10	1.20E-08	NA	1.60E-08
Dichloroethane, 1,1-	0.0485	1.55E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	4.01E-11	1.40E-10	7.01E-10	1.20E-10	2.41E-09	NA	3.11E-09
Tetrachloroethene	0.999	3.16E-08	4.6	0.00001	0.01	0.051	1	3.153E-10	1.103E-09	1.10E-11	9.458E-10	4.82E-11	1	8.17E-11	2.86E-09	6.22E-10	2.45E-09	2.45E-07	5.93E-11	2.46E-07
Trans-1,2-Dichloroethene	0.0485	1.55E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	4.01E-11	1.40E-10	2.00E-09	1.20E-10	6.01E-09	NA	8.02E-09
Trichloroethane, 1,1,1-	0.0767	2.45E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	6.34E-11	2.22E-10	4.27E-11	1.90E-10	2.11E-09	NA	2.16E-09
Trichloroethene	0.358	1.15E-08	0.18	0.0000017	0.002	0.011	1	1.141E-10	3.994E-10	6.79E-13	3.424E-10	3.77E-12	1	2.96E-10	1.04E-09	5.75E-09	8.88E-10	4.44E-07	4.45E-12	4.50E-07
Vinyl chloride	0.0485	1.55E-09	0.1	0.0000088	0.003	1.4	1	1.546E-11	5.411E-11	4.76E-13	4.638E-11	6.49E-11	1	4.01E-11	1.40E-10	1.40E-09	1.20E-10	4.01E-08	6.54E-11	4.15E-08
Total										1.42E-11		1.23E-10				1.59E-08		9.39E-07	1.37E-10	9.55E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-88

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Commercial Worker at other streets
Ambient Air

Receptor:	Commercial/Industrial Worker	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$
$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

OUTDOOR AIR DATA		Ambient Air (mg/m3)		RfC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Compound													
Carbon tetrachloride		NA		0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane		NA		10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform		NA		0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-		4.73E-04		0.5	NA	NC	NA	NA	1	5.18E-05	1.04E-04	NA	1.04E-04
Dichloroethene, cis-1,2-		4.61E-04		0.035	NA	NC	NA	NA	1	5.05E-05	1.44E-03	NA	1.44E-03
Dichloroethene, 1,1-		4.61E-04		0.2	NA	1	NA	NA	1	5.05E-05	2.53E-04	NA	2.53E-04
Tetrachloroethene		8.17E-04		4.6	0.00001	1	3.45E-05	3.45E-07	1	8.95E-05	1.95E-05	3.45E-07	1.95E-05
Trans-1,2-Dichloroethene		4.61E-04		0.07	NA	NC	NA	NA	1	5.05E-05	7.21E-04	NA	7.21E-04
Trichloroethane, 1,1,1-		6.42E-04		5.2	NA	NC	NA	NA	1	7.03E-05	1.35E-05	NA	1.35E-05
Trichloroethene		6.42E-04		0.18	0.0000017	1	2.71E-05	4.61E-08	1	7.03E-05	3.91E-04	4.61E-08	3.91E-04
Vinyl chloride		2.98E-04		0.1	0.0000088	1	1.26E-05	1.11E-07	1	3.26E-05	3.26E-04	1.11E-07	3.26E-04
Total								5.02E-07			3.27E-03	5.02E-07	3.27E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-89
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at other streets
Indoor Air
163 Glen Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	163 Glen Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC			URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Indoor Air)	HI (Indoor Air)
	Indoor Air (mg/m3)	RfC (mg/m3)										
Carbon tetrachloride	NA	0.43		0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10		NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66		0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5		NA	NC	NA	NA	1	9.25E-05	1.85E-04	NA	1.85E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035		NA	NC	NA	NA	1	9.02E-05	2.58E-03	NA	2.58E-03
Dichloroethene, 1,1-	3.95E-04	0.2		NA	1	NA	NA	1	9.02E-05	4.51E-04	NA	4.51E-04
Tetrachloroethene	1.50E-03	4.6		0.00001	1	1.32E-04	1.32E-06	1	3.42E-04	7.44E-05	1.32E-06	7.44E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07		NA	NC	NA	NA	1	9.02E-05	1.29E-03	NA	1.29E-03
Trichloroethane, 1,1,1-	9.30E-04	5.2		NA	NC	NA	NA	1	2.12E-04	4.08E-05	NA	4.08E-05
Trichloroethene	5.50E-04	0.18		0.0000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08	6.98E-04
Vinyl chloride	2.55E-04	0.1		0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07	5.82E-04
Total							1.60E-06			5.90E-03	1.60E-06	5.90E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-90
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at other streets
Indoor Air
85 Washington Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	85 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF1}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC			URF 1/(ug/m3)	Risk			HI (Indoor Air)
	Indoor Air (mg/m3)	RfC (mg/m3)	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	HIinh	
Carbon tetrachloride	NA	0.43	NA	NA	1	NA	NA	NA
Chloroethane	NA	10	NA	NA	1	NA	NA	NA
Chloroform	NA	0.66	NA	NA	1	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NA	1	9.25E-05	1.85E-04	1.85E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NA	1	9.02E-05	2.58E-03	2.58E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	NA	1	9.02E-05	4.51E-04	4.51E-04
Tetrachloroethene	1.40E-03	4.6	1.23E-04	1.23E-06	1	3.20E-04	6.95E-05	1.23E-06
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NA	1	9.02E-05	1.29E-03	1.29E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NA	1	1.26E-04	2.41E-05	NA
Trichloroethene	5.50E-04	0.18	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08
Vinyl chloride	2.55E-04	0.1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07
Total				1.51E-06			5.87E-03	1.51E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-91
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at other streets
Indoor Air
97 Washington Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	97 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC				URF 1/(ug/m3)	Risk			
	Indoor Air (mg/m3)	RfC (mg/m3)	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh	(Indoor Air)	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NA	NC	NA	NA	NA	NA
Chloroform	NA	0.66	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NA	NC	9.25E-05	1.85E-04	NA	1.85E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NA	NC	9.02E-05	2.58E-03	NA	2.58E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	NA	1	9.02E-05	4.51E-04	NA	4.51E-04
Tetrachloroethene	1.25E-03	4.6	1.10E-04	1.10E-06	1	2.85E-04	6.19E-05	1.10E-06	6.19E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NA	NC	9.02E-05	1.29E-03	NA	1.29E-03
Trichloroethane, 1,1,1-	5.71E-04	5.2	NA	NA	NC	1.30E-04	2.51E-05	NA	2.51E-05
Trichloroethene	5.50E-04	0.18	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08	6.98E-04
Vinyl chloride	2.55E-04	0.1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07	5.82E-04
Total				1.38E-06			5.87E-03	1.38E-06	5.87E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-92
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds In Air
50 Tufts Street, Somerville MA
UniFirst
Current Commercial Worker at other streets
Indoor Air
121 Washington Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	121 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC		RfC (mg/m3)	URF 1/(ug/m3)	Risk					Risk (Indoor Air)	HI (Indoor Air)
	Indoor Air (mg/m3)				RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	
Carbon tetrachloride	NA		0.43	0.000015	1	NA	NA	1	NA	NA	NA
Chloroethane	NA		10	NA	NC	NA	NA	1	NA	NA	NA
Chloroform	NA		0.66	0.000023	1	NA	NA	1	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04		0.5	NA	NC	NA	NA	1	9.25E-05	1.85E-04	1.85E-04
Dichloroethene, cis-1,2-	3.95E-04		0.035	NA	NC	NA	NA	1	9.02E-05	2.58E-03	2.58E-03
Dichloroethene, 1,1-	3.95E-04		0.2	NA	1	NA	NA	1	9.02E-05	4.51E-04	4.51E-04
Tetrachloroethene	1.50E-03		4.6	0.00001	1	1.32E-04	1.32E-06	1	3.42E-04	7.44E-05	1.32E-06
Trans-1,2-Dichloroethene	3.95E-04		0.07	NA	NC	NA	NA	1	9.02E-05	1.29E-03	1.29E-03
Trichloroethane, 1,1,1-	5.50E-04		5.2	NA	NC	NA	NA	1	1.26E-04	2.41E-05	2.41E-05
Trichloroethene	5.50E-04		0.18	0.0000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08
Vinyl chloride	2.55E-04		0.1	0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07
Total							1.60E-06			5.88E-03	1.60E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-93
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Current Student risks at Capuano School
Soil

Receptor:	Student (4 yr old)
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{cs} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm2/d	2495	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.35	
EF	Soil Exposure Frequency	d/y	208	
EPC	Soil Exposure Period - Cancer	y	2	
EPnc	Soil Exposure Period - Non-Cancer	y	2	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	730	
BW	Body Weight	kg	16.4	
CF	Conversion Factor	kg/mg	0.000001	

Compound	EPC (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hiling	
Carbon tetrachloride	0.0485	0.0007	0.13	1	4.82E-09	6.26E-10	1	1.69E-07	2.41E-04	1.17E-09
Chloroethane	0.12	0.4	NA	NC	NA	NA	1	4.17E-07	1.04E-06	NA
Chloroform	0.0485	0.01	NA	NC	NA	NA	1	1.69E-07	1.69E-05	NA
Dichloroethane, 1,1-	0.13	0.1	NA	NC	NA	NA	1.3	5.87E-07	5.87E-06	NA
Dichloroethane, 1,1,2-	0.0485	0.01	NA	NC	NA	NA	1	1.69E-07	1.69E-05	NA
Dichloroethene, 1,1-	0.0485	0.05	NA	NC	NA	NA	1	1.69E-07	3.37E-06	NA
Tetrachloroethene	0.989	0.01	0.051	1	9.82E-08	5.01E-09	1	3.44E-06	3.44E-04	9.38E-09
Trans-1,2-Dichloroethene	0.0485	0.02	NA	NC	NA	NA	1	1.69E-07	8.43E-06	NA
Trichloroethane, 1,1,1-	0.0767	0.09	NA	NC	NA	NA	1	2.67E-07	2.98E-06	NA
Trichloroethene	0.358	0.002	0.011	1	3.55E-08	3.91E-10	1	1.24E-06	6.22E-04	7.32E-10
Vinyl chloride	0.0485	0.003	1.4	1.53	7.37E-09	1.03E-08	1	1.69E-07	5.62E-05	1.97E-08
Total						1.63E-08			1.32E-03	3.10E-08
										2.47E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-94
Exposure and Risk Estimates Associated With Inhalation of Soil-Derives Particulates in Air
50 Tufts Street, Somerville MA
UnitFirst
Current Student risks at Capuano School
Ambient Air

Receptor:	Student (4 yr old)
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$

$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.3804	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	208	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	2	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	2	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	730	
BW	Body Weight	kg	16.4	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	Soil (mg/kg)	EPC	Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinc	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates In Air) YC-OC-A	HI (Particulates In Air) YC
Carbon tetrachloride		0.0485		1.55E-09	0.43	0.000015	0.0007	0.13	1	2.345E-12	8.206E-12	1.23E-13	7.034E-12	9.14E-13	1	8.21E-11	2.87E-10	6.88E-10	2.46E-10	3.52E-07	1.04E-12	3.52E-07
Chloroethane		0.12		3.84E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	2.03E-10	7.11E-10	7.11E-11	6.09E-10	1.52E-09	NA	1.59E-09
Chloroform		0.0485		1.55E-09	0.66	0.000023	0.01	NA	1	2.345E-12	8.206E-12	1.89E-13	7.034E-12	NA	1	8.21E-11	2.87E-10	4.35E-10	2.46E-10	2.46E-08	1.89E-13	2.51E-08
Dichloroethane, 1,1-		0.13		4.16E-09	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	2.20E-10	7.70E-10	1.54E-09	6.60E-10	6.60E-08	NA	8.14E-09
Dichloroethane, cis-1,2-		0.0485		1.55E-09	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	8.21E-11	2.87E-10	8.21E-09	2.46E-10	2.46E-08	NA	3.28E-08
Dichloroethene, 1,1-		0.0485		1.55E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	8.21E-11	2.87E-10	1.44E-09	2.46E-10	4.92E-09	NA	6.36E-09
Tetrachloroethene		0.989		3.16E-08	4.6	0.00001	0.01	0.051	1	4.781E-11	1.673E-10	1.67E-12	1.434E-10	7.31E-12	1	1.67E-09	5.86E-09	1.27E-09	5.02E-09	5.02E-07	8.99E-12	5.03E-07
Trans-1,2-Dichloroethene		0.0485		1.55E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	8.21E-11	2.87E-10	4.10E-09	2.46E-10	1.23E-08	NA	1.64E-08
Trichloroethene, 1,1,1-		0.0767		2.45E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	1.30E-10	4.54E-10	8.73E-11	3.89E-10	4.33E-09	NA	4.41E-09
Trichloroethane		0.358		1.15E-08	0.18	0.0000017	0.002	0.011	1	1.731E-11	6.057E-11	1.03E-13	5.192E-11	5.71E-13	1	6.06E-10	2.12E-09	1.18E-08	1.82E-09	9.09E-07	6.74E-13	9.20E-07
Vinyl chloride		0.0485		1.55E-09	0.1	0.0000088	0.003	1.4	1	2.345E-12	8.206E-12	7.22E-14	7.034E-12	9.85E-12	1	8.21E-11	2.87E-10	2.87E-09	2.46E-10	8.21E-08	9.92E-12	8.49E-08
Total												2.16E-12		1.86E-11				3.25E-08		1.92E-06	2.08E-11	1.96E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-95
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Current Student risks at Capuano School
Ambient Air
Volatilization from Ambient Air

Receptor:	Student (4 yr old)	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	208	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	2	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	2	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	730	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.73E-04	0.5	NA	NC	NA	NA	1	8.98E-05	1.80E-04	NA	1.80E-04
Dichloroethene, cis-1,2-	4.61E-04	0.035	NA	NC	NA	NA	1	8.75E-05	2.50E-03	NA	2.50E-03
Dichloroethene, 1,1-	4.61E-04	0.2	NA	1	NA	NA	1	8.75E-05	4.38E-04	NA	4.38E-04
Tetrachloroethene	8.17E-04	4.6	0.00001	1	4.43E-06	4.43E-08	1	1.55E-04	3.37E-05	4.43E-08	3.37E-05
Trans-1,2-Dichloroethene	4.61E-04	0.07	NA	NC	NA	NA	1	8.75E-05	1.25E-03	NA	1.25E-03
Trichloroethane, 1,1,1-	6.42E-04	5.2	NA	NC	NA	NA	1	1.22E-04	2.34E-05	NA	2.34E-05
Trichloroethene	6.42E-04	0.18	0.000017	1	3.48E-06	5.92E-09	1	1.22E-04	6.77E-04	5.92E-09	6.77E-04
Vinyl chloride	2.98E-04	0.1	0.0000088	1	1.61E-06	1.42E-08	1	5.65E-05	5.65E-04	1.42E-08	5.65E-04
Total						6.45E-08			5.67E-03	6.45E-08	5.67E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-96
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Resident at other streets
Soil

Receptor:	Resident	▼
Medium:	Soil	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IR _{soil}	Soil Ingestion Rate	mg/d	100	
IR _{soil} TWA	Soil TWA Ingestion Rate	mg-y/kg-d	64	
SA	Soil Dermal Contact Skin Exposed	cm ² /d	2431	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm ² -y/kg-d-cf	659	
AF	Soil Dermal Contact Adherence Rate	mg/cm ²	0.35	
EF	Soil Exposure Frequency	d/y	150	
EPc	Soil Exposure Period - Cancer	y	30	
EPnc	Soil Exposure Period - Non-Cancer	y	7	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	2555	
BW	Body Weight	kg	17	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der-nc} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$ADD_{ing-c} = \frac{C_{soil} \times CF \times IR_{soil} \times TWA \times RAF_{os} \times EF}{AP}$$

$$ADD_{der-c} = \frac{C_{soil} \times CF \times SATWA \times RAF_{ds} \times EF}{AP}$$

$$HI_{ing} = \frac{ADD_{ing-nc}}{RfD}$$

$$HI_{der} = \frac{ADD_{der-nc}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing-c} \times CSF$$

$$Risk_{der} = ADD_{der-c} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFosc	ADD _{ing-c} mg/kg-d	Risk _{ing}	RAFoscnc	ADD _{ing-nc} mg/kg-d	H _{ing}	Dermal Contact RAF _{ds}	ADD _{der-c} mg/kg-d	Risk _{der}	RAF _{ds} nc	ADD _{der-nc} mg/kg-d	H _{der}	Total Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.037	0.0007	0.13	1	1.38E-08	1.80E-09	1	8.94E-08	1.28E-04	0.1	1.43E-08	1.86E-09	0.1	7.61E-08	1.09E-04	3.66E-09	2.36E-04
Chloroform	0.037	0.01	NA	NA	NA	NA	1	8.94E-08	8.94E-06	NA	NA	NA	0.1	7.61E-08	7.61E-06	NA	1.66E-05
Dichloroethane, 1,1-	0.43	0.1	NA	NC	NA	NA	1.3	1.35E-06	1.35E-05	NC	NA	NA	0.13	1.15E-06	1.15E-05	NA	2.50E-05
Dichloroethene, cis-1,2-	0.772	0.01	NA	NC	NA	NA	1	1.87E-06	1.87E-04	NC	NA	NA	0.1	1.59E-06	1.59E-04	NA	3.45E-04
Dichloroethene, 1,1-	0.491	0.05	NA	NC	NA	NA	1	1.19E-06	2.37E-05	NC	NA	NA	0.1	1.01E-06	2.02E-05	NA	4.39E-05
Tetrachloroethene	58.9	0.01	0.051	1	2.20E-05	1.12E-06	1	1.42E-04	1.42E-02	0.1	2.28E-05	1.16E-06	0.1	1.21E-04	1.21E-02	2.28E-06	2.64E-02
Trans-1,2-Dichloroethene	0.037	0.02	NA	NC	NA	NA	1	8.94E-08	4.47E-06	NC	NA	NA	0.1	7.61E-08	3.81E-06	NA	8.28E-06
Trichloroethene, 1,1-	0.0767	0.09	NA	NC	NA	NA	1	1.85E-07	2.06E-06	NC	NA	NA	0.1	1.58E-07	1.75E-06	NA	3.81E-06
Trichloroethene	6.17	0.002	0.011	1	2.30E-06	2.53E-08	1	1.49E-05	7.46E-03	0.1	2.39E-06	2.63E-08	0.1	1.27E-05	6.35E-03	5.16E-08	1.38E-02
Vinyl chloride	0.037	0.003	1.4	1.53	2.11E-08	2.96E-08	1	8.94E-08	2.98E-05	0.16	2.29E-08	3.21E-08	0.1	7.61E-08	2.54E-05	6.17E-08	5.52E-05
Total						1.18E-06			2.21E-02			1.22E-06			1.88E-02	2.40E-06	4.09E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-97
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Future Resident at other streets
Ambient Air

Receptor	Resident	▼
Medium of Origin:	Soil	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	0-15 feet	▼
Duration:	Chronic	▼

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.36	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.60	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	150	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	30	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	7	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	2555	
BW	Body Weight	kg	17.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh-gi-nc} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$
$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh-nc} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70 \text{ kg}}{20 \text{ m}^3 / \text{d}}$$
$$HI = \frac{ADD_{inh-gi-nc}}{RfD} + \frac{ADE_{inh-nc}}{RfC}$$
$$Risk = (ADD_{inh-gi-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-c mg/m3	RiskRth	ADD-ingc	RiskRg	RAFinc	ADD-inhnc mg/kg-d	ADE-nc mg/m3	HlRth	ADD-ingnc	HlRng	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.037	1.18E-09	0.43	0.000015	0.0007	0.13	1	1.663E-11	5.821E-11	8.73E-13	6.652E-11	8.65E-12	1	4.12E-11	1.44E-10	3.35E-10	1.24E-10	1.77E-07	9.52E-12	1.77E-07
Chloroform	0.037	1.18E-09	0.66	0.000023	0.01	NA	1	1.663E-11	5.821E-11	1.34E-12	NA	NA	1	4.12E-11	1.44E-10	2.19E-10	1.24E-10	1.24E-08	1.34E-12	1.26E-08
Dichloroethane, 1,1-	0.43	1.38E-08	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	4.79E-10	1.68E-09	3.35E-09	1.44E-09	1.44E-08	NA	1.77E-08
Dichloroethane, cis-1,2-	0.772	2.47E-08	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	8.60E-10	3.01E-09	8.60E-08	2.58E-09	2.58E-07	NA	3.44E-07
Dichloroethane, 1,1-	0.491	1.57E-08	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	5.47E-10	1.91E-09	9.57E-09	1.64E-09	3.28E-08	NA	4.24E-08
Tetrachloroethene	58.9	1.88E-06	4.6	0.00001	0.01	0.051	1	2.647E-08	9.266E-08	9.27E-10	1.059E-07	5.40E-09	1	6.56E-08	2.30E-07	4.99E-08	1.97E-07	1.97E-05	6.33E-09	1.97E-05
Trans-1,2-Dichloroethene	0.037	1.18E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	4.12E-11	1.44E-10	2.06E-09	1.24E-10	6.18E-09	NA	8.24E-09
Trichloroethane, 1,1,1-	0.0767	2.48E-09	5.2	NA	0.09	NA	NC	NA	NA	1.65E-11	1.109E-08	1.22E-10	1	8.54E-11	2.98E-10	5.75E-11	2.56E-10	2.85E-09	NA	2.91E-09
Trichloroethene	6.17	1.97E-07	0.18	0.0000017	0.002	0.011	1	2.773E-09	9.706E-09	5.12E-13	6.652E-11	9.31E-11	1	6.87E-09	2.41E-08	1.34E-07	2.06E-08	1.03E-05	1.39E-10	1.04E-05
Vinyl chloride	0.037	1.18E-09	0.1	0.0000088	0.003	1.4	1	1.663E-11	5.821E-11	9.46E-10	5.62E-09	5.62E-09	1	4.12E-11	1.44E-10	1.44E-09	1.24E-10	4.12E-08	9.36E-11	4.27E-08
Total																2.87E-07		3.05E-05	6.57E-09	3.00E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-98
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Resident at other streets
Ambient Air

Receptor:	Resident	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	150	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	7	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	30	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	2555	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air Data Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	NA	0.5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethene, cis-1,2-	4.61E-04	0.035	NA	NC	NA	NA	1	6.31E-05	1.80E-03	NA	1.80E-03
Dichloroethene, 1,1-	4.61E-04	0.2	NA	1	4.79E-05	4.79E-07	1	6.31E-05	3.16E-04	NA	3.16E-04
Tetrachloroethene	8.17E-04	4.6	0.00001	1	NA	NA	1	1.12E-04	2.43E-05	4.79E-07	2.43E-05
Trans-1,2-Dichloroethene	4.61E-04	0.07	NA	NC	NA	NA	1	6.31E-05	9.02E-04	NA	9.02E-04
Trichloroethane, 1,1,1-	6.42E-04	5.2	NA	NC	NA	NA	1	8.79E-05	1.69E-05	NA	1.69E-05
Trichloroethene	6.42E-04	0.18	0.0000017	1	3.77E-05	6.40E-08	1	8.79E-05	4.88E-04	6.40E-08	4.88E-04
Vinyl chloride	2.98E-04	0.1	0.0000088	1	1.75E-05	1.54E-07	1	4.08E-05	4.08E-04	1.54E-07	4.08E-04
Total						6.97E-07			3.96E-03	6.97E-07	3.96E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-99

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Future Resident at other streets
 Indoor Air
 163 Glen Street

Receptor:	Resident	▼
Medium of Origin:	Indoor Air	▼
Exposure Medium:	Indoor Air	▼
Exposure Area:	163 Glen Street	▼
Depth:		▼
Duration:	Chronic	▼

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CFI}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	24	
EF	Indoor Air Exposure Frequency	d/y	365	
EP	Indoor Air Exposure Period - Cancer	y	30	
EP	Indoor Air Exposure Period - Non-Cancer	y	7	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	2555	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFIc	ADE-c mg/m3	Riskinh	RAFInc	ADE-nc mg/m3	HIinh	Risk (Indoor Air)	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.05E-04	8.10E-04	NA	8.10E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	3.95E-04	1.13E-02	NA	1.13E-02
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	3.95E-04	1.98E-03	NA	1.98E-03
Tetrachloroethene	1.50E-03	4.6	0.00001	1	6.43E-04	6.43E-06	1	1.50E-03	3.26E-04	6.43E-06	3.26E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	3.95E-04	5.64E-03	NA	5.64E-03
Trichloroethane, 1,1,1-	9.30E-04	5.2	NA	NC	NA	NA	1	9.30E-04	1.79E-04	NA	1.79E-04
Trichloroethene	5.50E-04	0.18	0.0000017	1	2.36E-04	4.01E-07	1	5.50E-04	3.06E-03	4.01E-07	3.06E-03
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.09E-04	9.62E-07	1	2.55E-04	2.55E-03	9.62E-07	2.55E-03
Total						7.79E-06			2.58E-02	7.79E-06	2.58E-02

NA - Not available
 NC - Not calculated
 ND - Not detected

Table A-100
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Resident at other streets
Indoor Air
85 Washington Street

Receptor:	Resident	▼
Medium of Origin:	Indoor Air	▼
Exposure Medium:	Indoor Air	▼
Exposure Area:	85 Washington Street	▼
Depth:		▼
Duration:	Chronic	▼

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times \Delta T}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	24	
EF	Indoor Air Exposure Frequency	d/y	365	
EP	Indoor Air Exposure Period - Cancer	y	30	
EP	Indoor Air Exposure Period - Non-Cancer	y	7	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	2555	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh	Risk (Indoor Air)	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.05E-04	8.10E-04	NA	8.10E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	3.95E-04	1.13E-02	NA	1.13E-02
Dichloroethane, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	3.95E-04	1.98E-03	NA	1.98E-03
Tetrachloroethene	1.40E-03	4.6	0.00001	1	NA	6.00E-06	1	1.40E-03	3.04E-04	6.00E-06	3.04E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	3.95E-04	5.64E-03	NA	5.64E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	5.50E-04	1.06E-04	NA	1.06E-04
Trichloroethene	5.50E-04	0.18	0.0000017	1	2.36E-04	4.01E-07	1	5.50E-04	3.06E-03	4.01E-07	3.06E-03
Vinyl chloride	2.55E-04	0.1	0.0000088	1	1.09E-04	9.62E-07	1	2.55E-04	2.55E-03	9.62E-07	2.55E-03
Total						7.36E-06			2.57E-02	7.36E-06	2.57E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-101
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Resident at other streets
Indoor Air
97 Washington Street

Receptor:	Resident
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	97 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	24	
EF	Indoor Air Exposure Frequency	d/y	365	
EP	Indoor Air Exposure Period - Cancer	y	30	
EP	Indoor Air Exposure Period - Non-Cancer	y	7	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	2555	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC		RfC (mg/m3)	URF 1/(ug/m3)	Risk				Risk (Indoor Air)	HI (Indoor Air)	
	Indoor Air (mg/m3)	RAFic			ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3			Hlinh
Carbon tetrachloride Chloroethane Chloroform Dichloroethane, 1,1- Dichloroethene, cis-1,2- Dichloroethene, 1,1- Tetrachloroethene Trans-1,2-Dichloroethene Trichloroethane, 1,1,1- Trichloroethene Vinyl chloride Total	NA	1	0.43	0.000015	NA	NA	NA	1	NA	NA	NA
	NA	NC	10	NA	NA	NA	NA	1	NA	NA	NA
	NA	1	0.66	0.000023	NA	NA	NA	1	NA	NA	NA
	4.05E-04	NC	0.5	NA	NA	NA	4.05E-04	1	4.05E-04	8.10E-04	8.10E-04
	3.95E-04	NC	0.035	NA	NA	NA	3.95E-04	1	3.95E-04	1.13E-02	1.13E-02
	3.95E-04	1	0.2	NA	NA	NA	3.95E-04	1	3.95E-04	1.98E-03	1.98E-03
	1.53E-03	1	4.6	0.00001	6.57E-04	6.57E-06	1.53E-03	1	1.53E-03	3.33E-04	3.33E-04
	3.95E-04	NC	0.07	NA	NA	NA	3.95E-04	1	3.95E-04	5.64E-03	5.64E-03
	6.37E-04	NC	5.2	NA	NA	NA	6.37E-04	1	6.37E-04	1.22E-04	1.22E-04
	5.50E-04	1	0.18	0.0000017	2.36E-04	4.01E-07	5.50E-04	1	5.50E-04	3.06E-03	3.06E-03
	2.55E-04	1	0.1	0.0000088	1.09E-04	9.62E-07	2.55E-04	1	2.55E-04	2.55E-03	2.55E-03
						7.93E-06				2.58E-02	2.58E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-102
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Resident at other streets
Indoor Air
121 Washington Street

Receptor:	Resident
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	121 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CFI}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	24	
EF	Indoor Air Exposure Frequency	d/y	365	
EP	Indoor Air Exposure Period - Cancer	y	30	
EP	Indoor Air Exposure Period - Non-Cancer	y	7	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	2555	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC			URF 1/(ug/m3)	Risk			Risk (Indoor Air)	HI (Indoor Air)
	Indoor Air (mg/m3)	RfC (mg/m3)	ADE-c mg/m3	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh
Carbon tetrachloride	NA	0.43	NA	1	NA	NA	1	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA
Chloroform	NA	0.66	NA	1	NA	NA	1	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	4.05E-04	8.10E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	3.95E-04	1.13E-02
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	3.95E-04	1.98E-03
Tetrachloroethene	1.50E-03	4.6	6.43E-04	1	6.43E-04	6.43E-06	1	1.50E-03	3.26E-04
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	3.95E-04	5.64E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	5.50E-04	1.06E-04
Trichloroethene	5.50E-04	0.18	2.36E-04	1	2.36E-04	4.01E-07	1	5.50E-04	3.06E-03
Vinyl chloride	2.55E-04	0.1	1.09E-04	1	1.09E-04	9.62E-07	1	2.55E-04	2.55E-03
Total						7.79E-06			2.58E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-103
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Commercial Worker at other streets
Soil

Receptor:	Commercial/Industrial Worker
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	50	
IRsoilTWA	Soil TWA Ingestion Rate	mg-y/kg-d	0	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
SATWA	Soil TWA Dermal Contact Skin Exposed	mg-cm2-y/kg-d-ci	0	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.03	
EF	Soil Exposure Frequency	d/y	120	
EPC	Soil Exposure Period - Cancer	y	27	
EPnc	Soil Exposure Period - Non-Cancer	y	27	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	9855	
BW	Body Weight	kg	61.1	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{oi} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total Risk (Soil) YC-OC-A	HI (Soil) YC
				RAFosc	ADDing-c mg/kg-d	Risking	RAFoscnc	ADDing-nc mg/kg-d	Hlder		
Carbon tetrachloride	0.037	0.0007	0.13	1	3.84E-09	4.99E-10	1	9.95E-09	2.96E-06	6.03E-10	1.72E-05
Chloroethane	0.095	0.4	NA	NC	NA	NA	1	2.56E-08	1.33E-08	NA	7.72E-08
Chloroform	0.037	0.01	NA	NA	NA	NA	1	9.95E-09	2.07E-07	NA	1.20E-06
Dichloroethane, 1,1-	0.43	0.1	NA	NC	NA	NA	1.3	1.50E-07	3.13E-08	NA	1.82E-06
Dichloroethane, cis-1,2-	0.772	0.01	NA	NC	NA	NA	1	2.08E-07	4.33E-06	NA	2.51E-05
Dichloroethane, 1,1-	0.491	0.05	NA	NC	NA	NA	1	1.32E-07	2.75E-08	NA	3.19E-06
Tetrachloroethene	58.9	0.01	0.051	1	6.11E-06	3.12E-07	1	1.58E-05	3.30E-04	3.77E-07	1.91E-03
Trans-1,2-Dichloroethene	0.037	0.02	NA	NC	NA	NA	1	9.95E-09	2.07E-07	NA	6.01E-07
Trichloroethane, 1,1,1-	0.0767	0.09	NA	NC	NA	NA	1	2.06E-08	4.30E-09	NA	2.77E-07
Trichloroethene	6.17	0.002	0.011	1	6.40E-07	7.04E-09	1	1.66E-06	3.46E-07	8.51E-09	1.00E-03
Vinyl chloride	0.037	0.003	1.4	1.53	5.87E-09	8.22E-09	1	9.95E-09	2.07E-09	1.00E-08	4.01E-06
Total						3.27E-07			5.12E-04	3.96E-07	2.97E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-104
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Commercial Worker at other streets
Ambient Air

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	1.2	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	120	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	27	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	d	27	
ATC	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	9855	
BW	Body Weight	kg	61.1	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-gt-c} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-gt-ne} = \frac{C_{air} \times 1.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADD_{inh-c} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_{ic} \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh-ne} = \frac{C_{air} \times 0.5 \times IR_{air} \times TWA \times RAF_{inc} \times ET \times EF \times C}{AP}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$

$$HI = \frac{ADD_{inh-gt-ne}}{RfD} + \frac{ADE_{inh-ne}}{RfC}$$

$$Risk = (ADD_{inh-gt-c} \times CSF) + (ADE_{inh-c} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inh-c mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFinc	ADD-inhnc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.037	1.18E-09	0.43	0.000015	0.0007	0.13	1	1.18E-11	4.128E-11	6.19E-13	3.539E-11	4.60E-12	1	3.06E-11	1.07E-10	2.49E-10	9.17E-11	1.31E-07	5.22E-12	1.31E-07
Chloroethane	0.095	3.04E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	7.85E-11	2.75E-10	2.75E-11	2.36E-10	5.89E-10	NA	6.16E-10
Chloroform	0.037	1.18E-09	0.66	0.000023	0.01	NA	1	1.18E-11	4.128E-11	9.49E-13	NA	NA	1	3.06E-11	1.07E-10	1.62E-10	9.17E-11	9.17E-09	9.49E-13	9.34E-09
Dichloroethane, 1,1-	0.43	1.38E-08	0.5	NA	0.1	NA	NC	NA	NA	NA	NA	NA	1	3.55E-10	1.24E-09	2.49E-09	1.07E-09	1.07E-08	NA	1.31E-08
Dichloroethene, cis-1,2-	0.772	2.47E-08	0.035	NA	0.01	NA	NC	NA	NA	NA	NA	NA	1	6.38E-10	2.23E-09	6.38E-08	1.91E-09	1.91E-07	NA	2.55E-07
Dichloroethene, 1,1-	0.491	1.57E-08	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	4.06E-10	1.42E-09	7.10E-09	1.22E-09	2.43E-08	NA	3.15E-07
Tetrachloroethene	58.9	1.88E-06	4.6	0.00001	0.01	0.051	1	1.878E-08	6.572E-08	6.57E-10	5.633E-08	2.87E-09	1	4.87E-08	1.70E-07	3.70E-08	1.46E-07	1.46E-05	3.53E-09	1.46E-05
Trans-1,2-Dichloroethene	0.037	1.18E-09	0.07	NA	0.02	NA	NC	NA	NA	NA	NA	NA	1	3.06E-11	1.07E-10	1.59E-09	9.17E-11	4.59E-09	NA	6.12E-09
Trichloroethane, 1,1,1-	0.0767	2.45E-09	5.2	NA	0.09	NA	NC	NA	NA	NA	NA	NA	1	6.34E-11	2.22E-10	4.27E-11	1.90E-10	2.11E-09	NA	2.16E-09
Trichloroethene	6.17	1.97E-07	0.18	0.0000017	0.002	0.011	1	1.967E-09	6.884E-09	1.17E-11	5.901E-09	6.49E-11	1	5.10E-09	1.78E-08	9.92E-08	1.53E-08	7.65E-06	7.66E-11	7.75E-06
Vinyl chloride	0.037	1.18E-09	0.1	0.0000088	0.003	1.4	1	1.18E-11	4.128E-11	3.63E-13	3.539E-11	4.95E-11	1	3.06E-11	1.07E-10	1.07E-09	9.17E-11	3.06E-08	4.99E-11	3.17E-08
Total										6.71E-10		2.99E-09				2.13E-07		2.27E-05	3.66E-09	2.29E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-105

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Commercial Worker at other streets
 Ambient Air

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Ambient Air
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	Shallow
Duration:	Chronic

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	120	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	27	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	27	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	9855	
C	Conversion Factor	ug/mg	1000	

Compound	Ambient Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane,1,1-	4.73E-04	0.5	NA	NC	NA	NA	1	5.18E-05	1.04E-04	NA	1.04E-04
Dichloroethene, cis-1,2-	4.61E-04	0.035	NA	NC	NA	NA	1	5.05E-05	1.44E-03	NA	1.44E-03
Dichloroethene,1,1-	4.61E-04	0.2	NA	1	NA	NA	1	5.05E-05	2.53E-04	NA	2.53E-04
Tetrachloroethene	8.17E-04	4.6	0.00001	1	3.45E-05	3.45E-07	1	8.95E-05	1.95E-05	3.45E-07	1.95E-05
Trans-1,2-Dichloroethene	4.61E-04	0.07	NA	NC	NA	NA	1	5.05E-05	7.21E-04	NA	7.21E-04
Trichloroethane,1,1,1-	6.42E-04	5.2	NA	NC	NA	NA	1	7.03E-05	1.35E-05	NA	1.35E-05
Trichloroethene	6.42E-04	0.18	0.0000017	1	2.71E-05	4.61E-08	1	7.03E-05	3.91E-04	4.61E-08	3.91E-04
Vinyl chloride	2.98E-04	0.1	0.0000088	1	1.26E-05	1.11E-07	1	3.26E-05	3.26E-04	1.11E-07	3.26E-04
Total						5.02E-07			3.27E-03	5.02E-07	3.27E-03

NA - Not available
 NC - Not calculated
 ND - Not detected

Table A-106
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker at other streets
Indoor Air
163 Glen Street

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CFI}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	163 Glen Street
Depth:	
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC		URF 1/(ug/m3)	Risk					Risk (Indoor Air)	HI (Indoor Air)
	Indoor Air (mg/m3)	RfC (mg/m3)		RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	HIinh	
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	9.25E-05	1.85E-04	1.85E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	9.02E-05	2.58E-03	2.58E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	9.02E-05	4.51E-04	4.51E-04
Tetrachloroethene	1.50E-03	4.6	0.00001	1	1.32E-04	1.32E-06	1	3.42E-04	7.44E-05	1.32E-06
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	9.02E-05	1.29E-03	NA
Trichloroethane, 1,1,1-	9.30E-04	5.2	NA	NC	NA	NA	1	2.12E-04	4.08E-05	NA
Trichloroethene	5.50E-04	0.18	0.0000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07
Total						1.60E-06			5.90E-03	1.60E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-107

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
 50 Tufts Street, Somerville MA
 UniFirst
 Future Commercial Worker at other streets
 Indoor Air
 85 Washington Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	85 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinC	ADE-nc mg/m3	HIinh	Risk (Indoor Air)	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	9.25E-05	1.85E-04	NA	1.85E-04
Dichloroethane, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	9.02E-05	2.58E-03	NA	2.58E-03
Dichloroethane, 1,1-	3.95E-04	0.2	NA	NC	NA	NA	1	9.02E-05	4.51E-04	NA	4.51E-04
Tetrachloroethene	1.40E-03	4.6	0.00001	1	1.23E-04	1.23E-06	1	3.20E-04	6.95E-05	1.23E-06	6.95E-05
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	9.02E-05	1.29E-03	NA	1.29E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	1.26E-04	2.41E-05	NA	2.41E-05
Trichloroethene	5.50E-04	0.18	0.000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08	6.98E-04
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07	5.82E-04
Total						1.51E-06			5.87E-03	1.51E-06	5.87E-03

NA - Not available

NC - Not calculated

ND - Not detected

Table A-108
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker at other streets
Indoor Air
97 Washington Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	97 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF}{24hr/d \times 365d/y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC				URF 1/(ug/m3)	RfC (mg/m3)	Risk				
	Indoor Air (mg/m3)	ADE-c mg/m3	Riskinh	RAFine	ADE-nc mg/m3	Hlinh	(Indoor Air)	(Indoor Air)	HI (Indoor Air)		
Carbon tetrachloride	NA	NA	NA	1	NA	NA	NA	NA	NA		
Chloroethane	NA	NA	NA	1	NA	NA	NA	NA	NA		
Chloroform	NA	NA	NA	1	NA	NA	NA	NA	NA		
Dichloroethane, 1,1'-	4.05E-04	NA	NA	1	9.25E-05	1.85E-04	NA	NA	1.85E-04		
Dichloroethane, cis-1,2-	3.95E-04	NA	NA	1	9.02E-05	2.58E-03	NA	NA	2.58E-03		
Dichloroethane, 1,1'-	3.95E-04	NA	NA	1	9.02E-05	4.51E-04	NA	NA	4.51E-04		
Tetrachloroethene	1.25E-03	1.10E-04	1.10E-06	1	2.85E-04	6.19E-05	1.10E-06	NA	6.19E-05		
Trans-1,2-Dichloroethene	3.95E-04	NA	NA	1	9.02E-05	1.29E-03	NA	NA	1.29E-03		
Trichloroethane, 1,1,1'-	5.71E-04	NA	NA	1	1.30E-04	2.51E-05	NA	NA	2.51E-05		
Trichloroethene	5.50E-04	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08	NA	6.98E-04		
Vinyl chloride	2.55E-04	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07	NA	5.82E-04		
Total			1.38E-06			5.87E-03			1.38E-06	5.87E-03	

NA - Not available
NC - Not calculated
ND - Not detected

Table A-109
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Commercial Worker at other streets
Indoor Air
121 Washington Street

Receptor:	Commercial/Industrial Worker
Medium of Origin:	Indoor Air
Exposure Medium:	Indoor Air
Exposure Area:	121 Washington Street
Depth:	
Duration:	Chronic

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP \times CF1}{24hr/d \times 365d/y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C2$$

Parameter	Definition	Units	Value	Comment
ET	Indoor Air Exposure Time	h/d	8	
EF	Indoor Air Exposure Frequency	d/y	250	
EP	Indoor Air Exposure Period - Cancer	y	27	
EP	Indoor Air Exposure Period - Non-Cancer	y	27	
ATc	Indoor Air Averaging Time - Cancer	d	25550	
ATn	Indoor Air Averaging Time - Non-Cancer	d	9855	
C1	Conversion Factor	d/y	365	
C2	Conversion Factor	ug/mg	1000	

Compound	EPC					Risk				
	Indoor Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFIc	ADE-c mg/m3	Riskinh	RAFInc	ADE-nc mg/m3	Hlinh	HI (Indoor Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA
Dichloroethane, 1,1-	4.05E-04	0.5	NA	NC	NA	NA	1	9.25E-05	1.85E-04	1.85E-04
Dichloroethene, cis-1,2-	3.95E-04	0.035	NA	NC	NA	NA	1	9.02E-05	2.58E-03	2.58E-03
Dichloroethene, 1,1-	3.95E-04	0.2	NA	1	NA	NA	1	9.02E-05	4.51E-04	4.51E-04
Tetrachloroethene	1.50E-03	4.6	0.00001	1	1.32E-04	1.32E-06	1	3.42E-04	7.44E-05	1.32E-06
Trans-1,2-Dichloroethene	3.95E-04	0.07	NA	NC	NA	NA	1	9.02E-05	1.29E-03	1.29E-03
Trichloroethane, 1,1,1-	5.50E-04	5.2	NA	NC	NA	NA	1	1.26E-04	2.41E-05	2.41E-05
Trichloroethene	5.50E-04	0.18	0.000017	1	4.84E-05	8.23E-08	1	1.26E-04	6.98E-04	8.23E-08
Vinyl chloride	2.55E-04	0.1	0.0000088	1	2.25E-05	1.98E-07	1	5.82E-05	5.82E-04	1.98E-07
Total						1.60E-06			5.88E-03	1.60E-06

NA - Not available
NC - Not calculated
ND - Not detected

Table A-110
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Future Student risks at schools on other streets
Soil

Receptor:	Student (4 yr old)
Medium:	Soil
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{soil} \times EF \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{fs} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm2/d	2495	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.35	
EF	Soil Exposure Frequency	d/y	208	
EPc	Soil Exposure Period - Cancer	y	2	
EPnc	Soil Exposure Period - Non-Cancer	y	2	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	730	
BW	Body Weight	kg	16.4	
CF	Conversion Factor	kg/mg	0.000001	

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFosc	ADDing-c mg/kg-d	Risking	RAFoscnc	ADDing-nc mg/kg-d	Hling	Dermal Contact RAFfsc	ADDder-c mg/kg-d	Riskder	RAFdsnc	ADDder-nc mg/kg-d	Hlder	Total Risk (Soil) YC-OC-A	HI (Soil) YC
Carbon tetrachloride	0.037	0.0007	0.13	1	3.67E-09	4.78E-10	1	1.29E-07	1.84E-04	0.1	3.21E-09	4.17E-10	0.1	1.12E-07	1.60E-04	8.95E-10	3.44E-04
Chloroethane	0.095	0.4	NA	NC	NA	NA	1	3.30E-07	8.25E-07	NC	NA	NA	0.1	2.88E-07	7.21E-07	NA	1.55E-06
Chloroform	0.037	0.01	NA	NA	NA	NA	1	1.29E-07	1.29E-05	NA	NA	NA	0.1	1.12E-07	1.12E-05	NA	2.41E-05
Dichloroethane, 1,1-	0.43	0.1	NA	NC	NA	NA	1.3	1.94E-06	1.94E-05	NC	NA	NA	0.13	1.70E-06	1.70E-05	NA	3.64E-05
Dichloroethene, cis-1,2-	0.772	0.01	NA	NC	NA	NA	1	2.68E-06	2.68E-04	NC	NA	NA	0.1	2.34E-06	2.34E-04	NA	5.03E-04
Dichloroethene, 1,1-	0.491	0.05	NA	NC	NA	NA	1	1.71E-06	3.41E-05	NC	NA	NA	0.1	1.49E-06	2.98E-05	NA	6.39E-05
Tetrachloroethene	58.9	0.01	0.051	1	5.85E-06	2.88E-07	1	2.05E-04	2.05E-02	0.1	5.11E-06	2.60E-07	0.1	1.79E-04	1.79E-02	5.59E-07	3.83E-02
Trans-1,2-Dichloroethene	0.037	0.02	NA	NC	NA	NA	1	1.29E-07	6.43E-06	NC	NA	NA	0.1	1.12E-07	5.61E-06	NA	1.20E-05
Trichloroethane, 1,1,1-	0.0767	0.09	NA	NC	NA	NA	1	2.67E-07	2.96E-06	NC	NA	NA	0.1	2.33E-07	2.59E-06	NA	5.55E-06
Trichloroethene	6.17	0.002	0.011	1	6.13E-07	6.74E-09	1	2.14E-05	1.07E-02	0.1	5.35E-07	5.88E-09	0.1	1.87E-05	9.36E-03	1.26E-08	2.01E-02
Vinyl chloride	0.037	0.003	1.4	1.53	5.62E-09	7.87E-09	1	1.29E-07	4.29E-05	0.16	5.13E-09	7.19E-09	0.1	1.12E-07	3.74E-05	1.51E-08	8.03E-05
Total						3.13E-07			3.18E-02			2.74E-07			2.77E-02	5.87E-07	5.95E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-111
Exposure and Risk Estimates Associated With Inhalation of Soil-Derives Particulates in Air
50 Tufts Street, Somerville MA
Unifirst
Future Student risks at schools on other streets
Ambient Air

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Receptor:	Student (4 yr old)
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Future
Depth:	0-15 feet
Duration:	Chronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	0.3804	
PEF	Outdoor Air PM10 - Particulates	ug/m3	32	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	208	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	2	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	2	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	730	
BW	Body Weight	kg	16.4	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inhc mg/kg-d	ADE-nc mg/m3	Hlinh	ADD-ingnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	0.037	1.18E-09	0.43	0.000015	0.0007	0.13	1	1.789E-12	6.26E-12	5.10E-10	1.88E-10	2.68E-07	7.91E-13	2.69E-07
Chloroethane	0.095	3.04E-09	10	NA	0.4	NA	NC	NA	5.63E-10	5.63E-11	4.82E-10	1.21E-09	NA	1.26E-09
Chloroform	0.037	1.18E-09	0.66	0.000023	0.01	NA	1	1.789E-12	6.26E-12	3.32E-10	1.88E-10	1.88E-08	1.44E-13	1.91E-08
Dichloroethane, 1,1-	0.43	1.36E-08	0.5	NA	0.1	NA	NC	NA	2.55E-09	5.09E-09	2.18E-09	2.18E-08	NA	2.69E-08
Dichloroethane, cis-1,2-	0.772	2.47E-08	0.035	NA	0.01	NA	NC	NA	4.57E-09	1.31E-07	3.92E-09	3.92E-07	NA	5.22E-07
Dichloroethene, 1,1-	0.491	1.57E-08	0.2	NA	0.05	NA	1	8.31E-10	2.91E-09	1.45E-08	2.49E-09	4.98E-08	NA	6.44E-08
Tetrachloroethene	58.9	1.88E-06	4.6	0.00001	0.01	0.051	1	9.97E-08	3.49E-07	7.58E-08	2.99E-07	2.99E-05	5.35E-10	3.00E-05
Trans-1,2-Dichloroethene	0.037	1.18E-09	0.07	NA	0.02	NA	NC	NA	2.19E-10	3.13E-09	1.88E-10	9.39E-09	NA	1.25E-08
Trichloroethane, 1,1,1-	0.0767	2.45E-09	5.2	NA	0.09	NA	NC	NA	4.54E-10	8.73E-11	3.89E-10	4.33E-09	NA	4.41E-09
Trichloroethene	6.17	1.97E-07	0.18	0.0000017	0.002	0.011	1	2.983E-10	1.044E-09	2.03E-07	3.13E-08	1.57E-05	1.16E-11	1.59E-05
Vinyl chloride	0.037	1.18E-09	0.1	0.0000088	0.003	1.4	1	1.789E-12	6.26E-12	2.19E-10	1.88E-10	6.26E-08	7.57E-12	6.48E-08
Total										4.35E-07		4.64E-05	5.55E-10	4.68E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-112
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Future Student risks at schools on other streets
Ambient Air
Volatilization from Ambient Air

Receptor:	Student (4 yr old)	▼
Medium of Origin:	Ambient Air	▼
Exposure Medium:	Ambient Air	▼
Exposure Area:	Future	▼
Depth:	Shallow	▼
Duration:	Chronic	▼

$$C_{air} = \frac{C_{source} \times VF}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	208	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	2	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	2	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	730	
C	Conversion Factor	ug/mg	1000	

Compound	Outdoor Air Data	RfC (mg/m3)	URF 1/(ug/m3)	RAFIc	ADE-c mg/m3	Riskinh	RAFInc	ADE-nc mg/m3	HIinh	Risk (Ambient Air)	HI (Ambient Air)
Carbon tetrachloride	NA	0.43	0.000015	1	NA	NA	1	NA	NA	NA	NA
Chloroethane	NA	10	NA	NC	NA	NA	1	NA	NA	NA	NA
Chloroform	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	4.73E-04	0.5	NA	NC	NA	NA	1	8.98E-05	1.80E-04	NA	1.80E-04
Dichloroethane, cis-1,2-	4.61E-04	0.035	NA	NC	NA	NA	1	8.75E-05	2.50E-03	NA	2.50E-03
Dichloroethane, 1,1-	4.61E-04	0.2	NA	1	NA	NA	1	8.75E-05	4.38E-04	NA	4.38E-04
Tetrachloroethene	8.17E-04	4.6	0.00001	1	4.43E-06	4.43E-08	1	1.55E-04	3.37E-05	4.43E-08	3.37E-05
Trans-1,2-Dichloroethene	4.61E-04	0.07	NA	NC	NA	NA	1	8.75E-05	1.25E-03	NA	1.25E-03
Trichloroethane, 1,1,1-	6.42E-04	5.2	NA	NC	NA	NA	1	1.22E-04	2.34E-05	NA	2.34E-05
Trichloroethene	6.42E-04	0.18	0.0000017	1	3.48E-06	5.92E-09	1	1.22E-04	6.77E-04	5.92E-09	6.77E-04
Vinyl chloride	2.98E-04	0.1	0.0000088	1	1.61E-06	1.42E-08	1	5.65E-05	5.65E-04	1.42E-08	5.65E-04
Total						6.45E-08			5.67E-03	6.45E-08	5.67E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-113
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
Unifirst
Construction Worker at other streets
Soil - Dermal contact & Incidental Ingestion

Receptor:	Construction Worker
Medium:	Surface Soil
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRsoil	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.29	
EF	Soil Exposure Frequency	d/y	130	
EP	Soil Exposure Period - Cancer	y	1	
EP	Soil Exposure Period - Non-Cancer	y	1	
ATc	Soil Averaging Time - Cancer	d	25550	
ATn	Soil Averaging Time - Non-Cancer	d	182	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF_{os} \times EF \times EP}{AP \times BW}$$
$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF_{ds} \times EF \times EP}{AP \times BW}$$
$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$
$$HI_{der} = \frac{ADD_{der}}{RfD}$$
$$HI = HI_{ing} + HI_{der}$$
$$Risk_{ing} = ADD_{ing} \times CSF$$
$$Risk_{der} = ADD_{der} \times CSF$$
$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact			Total							
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosnc	ADDing-nc mg/kg-d	Hling	RAFDsc	ADDder-c mg/kg-d	Riskder	RAFDsnc	ADDder-nc mg/kg-d	Hlder	Risk (Soil)	HI (Soil)
Carbon tetrachloride	0.037	0.007	0.13	1	3.25E-10	4.22E-11	1	4.56E-08	6.51E-06	0.1	3.27E-10	4.25E-11	0.1	4.59E-08	6.56E-06	8.47E-11	1.31E-05
Chloroethane	0.095	0.4	NA	NC	NA	NA	1	1.17E-07	2.92E-07	NC	NA	NA	0.1	1.18E-07	2.95E-07	NA	5.87E-07
Chloroform	0.037	0.01	NA	NA	NA	NA	1	4.56E-08	4.56E-06	NA	NA	NA	0.1	4.59E-08	4.59E-06	NA	9.15E-06
Dichloroethane, 1,1-	0.43	1	NA	NC	NA	NA	1.3	6.88E-07	6.88E-07	NC	NA	NA	0.13	6.93E-07	6.93E-07	NA	1.38E-06
Dichloroethene, cis-1,2-	0.772	0.1	NA	NC	NA	NA	1	9.51E-07	9.51E-06	NC	NA	NA	0.1	9.58E-07	9.58E-06	NA	1.91E-05
Dichloroethene, 1,1-	0.491	0.05	NA	NC	NA	NA	1	6.05E-07	1.21E-05	NC	NA	NA	0.1	6.09E-07	1.22E-05	NA	2.43E-05
Tetrachloroethene	58.9	0.1	0.051	1	5.17E-07	2.64E-08	1	7.25E-05	7.25E-04	0.1	5.20E-07	2.65E-08	0.1	7.31E-05	7.31E-04	5.29E-08	1.46E-03
Trans-1,2-Dichloroethene	0.037	0.2	NA	NC	NA	NA	1	4.56E-08	2.28E-07	NC	NA	NA	0.1	4.59E-08	2.29E-07	NA	4.57E-07
Trichloroethane, 1,1,1-	0.0767	0.9	NA	NC	NA	NA	1	9.45E-08	1.05E-07	NC	NA	NA	0.1	9.51E-08	1.06E-07	NA	2.11E-07
Trichloroethene	6.17	0.02	0.011	1	5.41E-08	5.95E-10	1	7.60E-06	3.80E-04	0.1	5.45E-08	6.00E-10	0.1	7.65E-06	3.83E-04	1.20E-09	7.63E-04
Vinyl chloride	0.037	0.003	1.4	1.53	4.97E-10	6.95E-10	1	4.56E-08	1.52E-05	0.16	5.23E-10	7.32E-10	0.1	4.59E-08	1.53E-05	1.43E-09	3.05E-05
Total						2.77E-08			1.15E-03			2.79E-08			1.16E-03	5.56E-08	2.32E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-114
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets
Ambient Air

Receptor:	Construction Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Excavation
Depth:	0-15 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	130	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	182	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$

$$ADD_{inh-g} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$

$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3/d}$$

$$HI = \frac{ADD_{inh-g}}{RfD} + \frac{ADE_{inh}}{RfC}$$

$$Risk = (ADD_{inh-g} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFic	ADD-inh-c mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	HLinh	ADD-ingnc	HLing	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	3.70E-02	2.22E-09	0.43	0.000015	0.007	0.13	1	2.804E-12	9.815E-12	1.47E-13	8.413E-12	1.09E-12	1.18E-09	1.69E-07	1.24E-12	1.72E-07
Chloroethane	9.50E-02	5.70E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	3.03E-09	7.58E-09	NA	7.94E-09
Chloroform	3.70E-02	2.22E-09	0.66	0.000023	0.01	NA	1	2.804E-12	9.815E-12	2.26E-13	NA	NA	1.18E-09	1.18E-07	2.26E-13	1.20E-07
Dichloroethane, 1,1-	4.30E-01	2.58E-08	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1.37E-08	1.37E-08	NA	1.69E-08
Dichloroethane, cis-1,2-	7.72E-01	4.63E-08	0.035	NA	0.1	NA	NC	NA	NA	NA	NA	NA	2.46E-08	2.46E-07	NA	1.07E-06
Dichloroethane, 1,1-	4.91E-01	2.95E-08	0.2	NA	0.05	NA	1	4.464E-09	1.563E-08	1.56E-10	1.339E-08	NA	1.57E-08	3.13E-07	NA	4.05E-07
Tetrachloroethene	5.89E+01	3.53E-06	4.6	0.00001	0.1	0.051	1	4.677E-10	1.637E-09	2.78E-12	1.403E-09	6.83E-10	1.88E-06	1.88E-05	8.39E-10	1.93E-05
Trans-1,2-Dichloroethene	3.70E-02	2.22E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1.18E-09	5.91E-09	NA	7.87E-09
Trichloroethane, 1,1,1-	7.67E-02	4.60E-09	5.2	NA	0.9	NA	1	4.677E-10	1.637E-09	2.78E-12	1.403E-09	1.54E-11	2.45E-09	2.72E-09	NA	3.27E-09
Trichloroethene	6.17E+00	3.70E-07	0.18	0.0000017	0.02	0.011	1	2.804E-12	9.815E-12	8.64E-14	8.413E-12	1.18E-11	1.97E-07	9.85E-06	1.82E-11	1.11E-05
Vinyl chloride	3.70E-02	2.22E-09	0.1	0.0000088	0.003	1.4	1	2.804E-12	9.815E-12	1.59E-10	7.11E-10	1.18E-11	1.18E-09	3.94E-07	1.19E-11	4.07E-07
Total														2.99E-05	8.71E-10	3.26E-05

NA - Not available
NC - Not calculated
ND - Not detected

Table A-115
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets

Compound	Henry's Law Constant at Avg GW Temp (conc/conc) H' _{TS}	Deff Vadose Zone (Layer A + Layer B)	Deff Total (Layer A + Layer B + Layer C)	Deffcrack (Layer A)	Exponent of Peclet Number	Organic Carbon- Water Partition Coefficient Koc	Volatilization from Subsurface Soil to Excavation Air VF	Volatilization from Subsurface Soil to Trench Air VF	Volatilization from Soil Gas to Excavation Air Alpha	Volatilization from Soil Gas to Trench Air Alpha (mg/m3 trench) / (mg/m3 SG)	Volatilization from Groundwater to Excavation Air VF	Volatilization from Groundwater to Trench Air VF
Carbon tetrachloride	5.88E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	152	1.53E-03	6.95E-03	9.35E-05	6.13E-06	3.91E-02	2.56E-03
Chloroethane	4.77E-01	5.35E-02	3.80E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.64E-02	3.25E-04	2.13E-05	1.10E-01	7.21E-03
Chloroform	8.04E-02	2.05E-02	1.46E-02	2.05E-02	1.20E+78	52.5	1.11E-03	5.06E-03	1.25E-04	8.17E-06	7.13E-03	4.67E-04
Dichloroethane, 1,1-	1.24E-01	1.46E-02	1.04E-02	1.46E-02	2.74E+109	53.4	1.15E-03	5.25E-03	8.89E-05	5.83E-06	7.86E-03	5.15E-04
Dichloroethene, cis-1,2-	8.79E-02	1.45E-02	1.03E-02	1.45E-02	2.13E+110	35.5	1.17E-03	5.34E-03	8.82E-05	5.78E-06	5.52E-03	3.62E-04
Dichloroethene, 1,1-	6.34E-01	1.78E-02	1.26E-02	1.78E-02	1.68E+90	65	2.51E-03	1.14E-02	1.08E-04	7.07E-06	4.86E-02	3.18E-03
Tetrachloroethene	3.24E-01	1.42E-02	1.01E-02	1.42E-02	6.04E+112	265	8.42E-04	3.83E-03	8.63E-05	5.65E-06	1.99E-02	1.30E-03
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	9.91E-03	1.40E-02	7.16E+114	38	1.71E-03	7.75E-03	8.48E-05	5.55E-06	1.28E-02	8.42E-04
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	1.09E-02	1.54E-02	1.28E+104	135	1.29E-03	5.85E-03	9.35E-05	6.13E-06	2.43E-02	1.59E-03
Trichloroethene	1.97E-01	1.56E-02	1.11E-02	1.56E-02	6.13E+102	94.3	1.14E-03	5.18E-03	9.47E-05	6.20E-06	1.33E-02	8.70E-04
Vinyl chloride	7.65E-01	2.09E-02	1.49E-02	2.09E-02	4.04E+76	18.6	4.71E-03	2.14E-02	1.27E-04	8.32E-06	6.91E-02	4.52E-03

Table A-116
Site-specific Parameters for Volatilization Calculations
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets

Symbol	(units)	Parameter	Value	Comment
L _{trench}	(cm)	Thickness of foundation	15.0	
f _{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02	
L _f	(15 or 200 cm)	Depth below grade to bottom of enclosed space floor	15	Input either 15 or 200
L _{wf}	(cm)	Depth below grade to water table	462.0768	Ft.
T _s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)
L _r	(cm)	Source- building separation	447.0768	DEP Default
L _g	(cm)	Length of building	961	DEP Default
W _a	(cm)	Width of building	961	DEP Default
H _g	(cm)	Height of building	488	DEP Default
X _{crack}	(l/hr)	Floor- wall seam perimeter	3844.00	DEP Default
ER	(cm ³ /s)	Air exchange rate	0.45	DEP Default
Q _{building}	(cm ³ /s)	Bldg. ventilation rate	56334.781	
A _g	(cm ²)	Area of enclosed space below grade	923521	
η	(unitless)	Crack- to-total area ratio	0.000416233	
Z _{crack}	(cm)	Crack depth below grade	15.0	
μ _{TS}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414	
L _d	(cm)	Diffusion path length	447.0768	
L _p	(cm)	Convection path length	15	
f _{trench}	(cm)	Crack radius	0.10	DEP Default
ΔP	g/cm-s ²	Pressure differential between soil surface and enclosed space	40.00	DEP Default
Q _{soil}	(cm ³ /s)	Average vapor flow rate into bldg.	9.454788E+01	
A _{crack}	(cm ²)	Area of crack	384.4	
R _c	(cal/mol-K)	Gas constant	1.9872	
R	(atm-m3/mol-K)	Universal gas constant	0.00008205	
R ₂	(mmHg-cm3/mol-K)	Universal gas constant	62361	
W _{SA}	(cm)	Width of soil source to ambient air	1524	50 Ft.
I _{SA}	(s)	Averaging time for volatilization from soil to ambient air	15768000	0.5 y
U	(cm/s)	Wind speed	225	
D	(cm)	Mixing height	182.88	6 Ft.
Z _s	(cm)	Depth to soil source	462.0768	15.16 Ft.
Z _{sg}	(cm)	Depth to soil gas source	462.0768	15.16 Ft.
W _E	(cm)	Width of excavation	1524	50 Ft.
L _E	(cm)	Length of excavation	762	25 Ft.
H _E	(cm)	Height of excavation	457.2	15 Ft.
W _{Ec}	(cm)	Width of excavation that is contaminated	1524	50 Ft.
L _{Ec}	(cm)	Length of excavation that is contaminated	762	25 Ft.
H _{Ec}	(cm)	Height of excavation that is contaminated	457.2	15 Ft.
WT	(cm)	Width of trench	457.2	15 Ft.
LT	(cm)	Length of trench	121.92	4 Ft.
HT	(cm)	Height of trench	182.88	6 Ft.
W _{Tc}	(cm)	Width of trench that is contaminated	457.2	15 Ft.
L _{Tc}	(cm)	Length of trench that is contaminated	121.92	4 Ft.
H _{Tc}	(cm)	Height of trench that is contaminated	182.88	6 Ft.
I _{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y
I _{sr}	(s)	Averaging time for volatilization from soil to trench	31536000	1 y
F _E	(unitless)	Fraction of wind speed that occurs in excavation	0.5	
F _T	(unitless)	Fraction of wind speed that occurs in trench	0.1	
d	(cm)	Lower depth of surface soil source	462.0768	15.16 Ft.
P _o	(g/cm ³)	Vadose zone soil dry bulk density	Layer A	Vadose Zone
n	(unitless)	Vadose zone soil total porosity	1.5	Layer B
θ _w	(cm ³ /cm ³)	Vadose zone soil water-filled porosity	0.43	0.43
θ _a	(cm ³ /cm ³)	Vadose zone soil air-filled porosity	0.06	0.253258113
h	(cm)	Thickness of soil layer	0.37	0.176741887
S _{se}	(cm ³ /cm ³)	Vadose zone effective total fluid saturation	15	415.0313455
k _i	(cm ²)	Vadose zone soil intrinsic permeability		0.018567639
k _{ap}	(cm ²)	Vadose zone soil relative air permeability		9.92425E-08
k _e	(cm ²)	Vadose zone soil effective vapor permeability		0.986637033
				9.79163E-08

Values Assume all sources are 1 inch below excavation depth

Table A-117

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets
Excavation Air
Volatilization from Soil Gas

Receptor:	Construction Worker	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha) SDF}{SDF}$$
$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil Gas mg/m3	Alpha Volatilization from Soil Gas to Excavation Air (mg/m3 excav) / (mg/m3 SG)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	8.65E-01	9.35E-05	1	8.09E-05	0.43	0.000015	1	1.37E-07	2.06E-09	1	9.61E-06	2.23E-05	2.06E-09	2.23E-05
Chloroethane	3.65E-01	3.25E-04	1	1.18E-04	10	NA	NC	NA	NA	1	1.41E-05	1.41E-06	NA	1.41E-06
Chloroform	NA	1.25E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	1.03E+00	8.89E-05	1	9.17E-05	5	NA	NC	NA	NA	1	1.09E-05	2.18E-06	NA	2.18E-06
Dichloroethane, cis-1,2-	1.68E+00	8.82E-05	1	1.48E-04	0.035	NA	NC	NA	NA	1	1.76E-05	5.02E-04	NA	5.02E-04
Dichloroethane, 1,1-	1.31E+00	1.08E-04	1	1.42E-04	0.2	NA	1	NA	NA	1	1.68E-05	8.40E-05	NA	8.40E-05
Tetrachloroethene	3.32E+02	8.63E-05	1	2.87E-02	4.6	0.00001	1	4.86E-05	4.86E-07	1	3.40E-03	7.40E-04	4.86E-07	7.40E-04
Trans-1,2-Dichloroethene	5.46E-01	8.48E-05	1	4.63E-05	0.7	NA	NC	NA	NA	1	5.50E-06	7.85E-06	NA	7.85E-06
Trichloroethane, 1,1,1-	3.66E+00	9.35E-05	1	3.42E-04	5.2	NA	NC	NA	NA	1	4.06E-05	7.81E-06	NA	7.81E-06
Trichloroethene	2.84E+00	9.47E-05	1	2.69E-04	0.18	0.000017	1	4.57E-07	7.76E-10	1	3.20E-05	1.78E-04	7.76E-10	1.78E-04
Vinyl chloride	3.53E-01	1.27E-04	1	4.48E-05	0.1	0.0000088	1	7.60E-08	6.69E-10	1	5.32E-06	5.32E-05	6.69E-10	5.32E-05
Total									4.90E-07			1.60E-03	4.90E-07	1.60E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-118
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets
Excavation Air
Volatilization from Subsurface Soil

Receptor:	Construction Worker	▼
Medium of Origin:	Subsurface Soil	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Subsurface Soil mg/kg	VF Volatilization from Subsurface Soil to Excavation Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	Riskinh	RAFiC	ADE-nc mg/m3	Hlinh	Risk (Excavation Air)	HI (Excavation Air)
Carbon tetrachloride	3.70E-02	1.53E-03	1	5.66E-05	0.43	0.000015	1	9.60E-08	1.44E-09	1	6.72E-06	1.56E-05	1.44E-09	1.56E-05
Chloroethane	9.50E-02	5.80E-03	1	5.51E-04	10	NA	NC	NA	NA	1	6.54E-05	6.54E-06	NA	6.54E-06
Chloroform	3.70E-02	1.11E-03	1	4.12E-05	0.66	0.000023	1	6.99E-08	1.61E-09	1	4.89E-06	7.41E-06	1.61E-09	7.41E-06
Dichloroethane, 1,1-	4.30E-01	1.15E-03	1	4.96E-04	5	NA	NC	NA	NA	1	5.89E-05	1.18E-05	NA	1.18E-05
Dichloroethane, cis-1,2-	7.72E-01	1.17E-03	1	9.07E-04	0.035	NA	NC	NA	NA	1	1.08E-04	3.08E-03	NA	3.08E-03
Dichloroethane, 1,1,1-	4.91E-01	2.51E-03	1	1.23E-03	0.2	NA	1	NA	NA	1	1.46E-04	7.30E-04	NA	7.30E-04
Tetrachloroethene	5.89E+01	8.42E-04	1	4.96E-02	4.6	0.00001	1	8.41E-05	8.41E-07	1	5.89E-03	1.28E-03	8.41E-07	1.28E-03
Trans-1,2-Dichloroethene	3.70E-02	1.71E-03	1	6.31E-05	0.7	NA	NC	NA	NA	1	7.49E-06	1.07E-05	NA	1.07E-05
Trichloroethane, 1,1,1-	7.67E-02	1.29E-03	1	9.88E-05	5.2	NA	NC	NA	NA	1	1.17E-05	2.26E-06	NA	2.26E-06
Trichloroethene	6.17E+00	1.14E-03	1	7.03E-03	0.18	0.000017	1	1.19E-05	2.03E-08	1	8.35E-04	4.64E-03	2.03E-08	4.64E-03
Vinyl chloride	3.70E-02	4.71E-03	1	1.74E-04	0.1	0.0000088	1	2.96E-07	2.60E-09	1	2.07E-05	2.07E-04	2.60E-09	2.07E-04
Total									8.67E-07			9.98E-03	8.67E-07	9.98E-03

NA - Not available
NC - Not calculated
ND - Not detected

Table A-119
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets
Excavation Air
Volatilization from Groundwater

Receptor:	Construction Worker	▼
Medium of Origin:	Groundwater	▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$
$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	2550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC (mg/L)	VF Volatilization from Groundwater to Excavation Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFIc	ADE-c mg/m3	Riskinh	RAFInc	ADE-nc mg/m3	HIinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	5.00E-04	3.91E-02	1	1.95E-05	0.43	0.000015	1	3.31E-08	4.97E-10	1	2.32E-06	5.39E-06	4.97E-10	5.39E-06
Chloroethane	1.48E-02	1.10E-01	1	1.63E-03	10	NA	NC	NA	NA	1	1.94E-04	1.94E-05	NA	1.94E-05
Chloroform	8.94E-03	7.13E-03	1	6.37E-05	0.66	0.000023	1	1.08E-07	2.49E-09	1	7.56E-06	1.15E-05	2.49E-09	1.15E-05
Dichloroethane, 1,1-	7.67E-02	7.86E-03	1	6.03E-04	5	NA	NC	NA	NA	1	7.16E-05	1.43E-05	NA	1.43E-05
Dichloroethene, cis-1,2-	1.98E-01	5.52E-03	1	1.09E-03	0.035	NA	NC	NA	NA	1	1.30E-04	3.71E-03	NA	3.71E-03
Dichloroethene, 1,1-	4.29E-02	4.86E-02	1	2.09E-03	0.2	NA	1	NA	NA	1	2.48E-04	1.24E-03	NA	1.24E-03
Tetrachloroethene	6.67E+00	1.99E-02	1	1.33E-01	4.6	0.00001	1	2.25E-04	2.25E-06	1	1.57E-02	3.42E-03	2.25E-06	3.42E-03
Trans-1,2-Dichloroethene	7.58E-03	1.28E-02	1	9.74E-05	0.7	NA	NC	NA	NA	1	1.16E-05	1.65E-05	NA	1.65E-05
Trichloroethane, 1,1,1-	9.08E-02	2.43E-02	1	2.20E-03	5.2	NA	NC	NA	NA	1	2.62E-04	5.03E-05	NA	5.03E-05
Trichloroethene	1.52E-01	1.33E-02	1	2.02E-03	0.18	0.0000017	1	3.43E-06	5.83E-09	1	2.40E-04	1.33E-03	5.83E-09	1.33E-03
Vinyl chloride	5.80E-02	6.91E-02	1	4.00E-03	0.1	0.0000088	1	6.79E-06	5.97E-08	1	4.75E-04	4.75E-03	5.97E-08	4.75E-03
Total									2.32E-06			1.46E-02	2.32E-06	1.46E-02

NA - Not available
NC - Not calculated
ND - Not detected

Table A-120
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Construction Worker at other streets
Excavation Air

Receptor:	Construction Worker	▼
Medium of Origin:		▼
Exposure Medium:	Excavation Air	▼
Exposure Area:	Excavation	▼
Depth:	0-15 feet	▼
Duration:	Subchronic	▼

All 3 media

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	130	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	1	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	1	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	182	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Average of 3 media (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	5.24E-05	0.43	0.000015	1	8.88E-08	1.33E-09	1	6.22E-06	1.45E-05	1.33E-09	1.45E-05
Chloroethane	7.67E-04	10	NA	NC	NA	NA	1	9.10E-05	9.10E-06	NA	9.10E-06
Chloroform	5.24E-05	0.66	0.000023	1	8.90E-08	2.05E-09	1	6.23E-06	9.43E-06	2.05E-09	9.43E-06
Dichloroethane, 1,1-	3.97E-04	5	NA	NC	NA	NA	1	4.71E-05	9.43E-06	NA	9.43E-06
Dichloroethene, cis-1,2-	7.16E-04	0.035	NA	NC	NA	NA	1	8.50E-05	2.43E-03	NA	2.43E-03
Dichloroethene, 1,1-	1.15E-03	0.2	NA	1	NA	NA	1	1.37E-04	6.84E-04	NA	6.84E-04
Tetrachloroethene	7.03E-02	4.6	0.00001	1	1.19E-04	1.19E-06	1	8.34E-03	1.81E-03	1.19E-06	1.81E-03
Trans-1,2-Dichloroethene	6.89E-05	0.7	NA	NC	NA	NA	1	8.19E-06	1.17E-05	NA	1.17E-05
Trichloroethane, 1,1,1-	8.82E-04	5.2	NA	NC	NA	NA	1	1.05E-04	2.01E-05	NA	2.01E-05
Trichloroethene	3.11E-03	0.18	0.0000017	1	5.27E-06	8.96E-09	1	3.69E-04	2.05E-03	8.96E-09	2.05E-03
Vinyl chloride	1.41E-03	0.1	0.0000088	1	2.39E-06	2.10E-08	1	1.67E-04	1.67E-03	2.10E-08	1.67E-03
Total						1.23E-06			8.72E-03	1.23E-06	8.72E-03

NA - Not available
NC - Not calculated
ND - Not detected
Assumes groundwater is directly beneath the excavation

Table A-121
Exposure and Risk Estimates Associated With Soil Contact
50 Tufts Street, Somerville MA
UniFirst
Utility Worker in streets
Soil - Dermal contact & Incidental Ingestion

Receptor:	Utility Worker
Medium:	Surface Soil
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IR _{soil}	Soil Ingestion Rate	mg/d	100	
SA	Soil Dermal Contact Skin Exposed	cm2/d	3473	
AF	Soil Dermal Contact Adherence Rate	mg/cm2	0.29	
EF	Soil Exposure Frequency	d/y	1	
EP	Soil Exposure Period - Cancer	y	5	
EP	Soil Exposure Period - Non-Cancer	y	5	
ATc	Soil Exposure Time - Cancer	d	25550	
ATn	Soil Exposure Time - Non-Cancer	d	1825	
BW	Body Weight	kg	58	
CF	Conversion Factor	kg/mg	0.000001	

$$ADD_{ing} = \frac{C_{soil} \times CF \times IR_{soil} \times RAF'_{os} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{soil} \times CF \times SA \times AF \times RAF'_{ds} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk_{ing} = ADD_{ing} \times CSF$$

$$Risk_{der} = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Compound	EPC Soil (mg/kg)	RID (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion			Dermal Contact					Total Risk (Soil)	HI (Soil)				
				RAFosc	ADDing-c mg/kg-d	Risking	RAFosc	ADDder-c mg/kg-d	Riskder	RAFDsnc mg/kg-d	ADDder-nc mg/kg-d			Hlder			
Carbon tetrachloride	0.0278	0.007	0.13	1	9.38E-12	1.22E-12	1	1.31E-10	1.88E-08	0.1	9.45E-12	1.23E-12	0.1	1.32E-10	1.89E-08	3.77E-08	
Chloroethane	0.0555	0.4	NA	NC	NA	NA	1	2.62E-10	6.55E-10	0.1	NA	NA	0.1	2.64E-10	6.60E-10	1.32E-09	
Chloroform	0.0278	0.01	NA	NA	NA	NA	1	1.31E-10	1.31E-08	0.1	NA	NA	0.1	1.32E-10	1.32E-08	2.64E-08	
Dichloroethane, 1,1-	0.13	1	NA	NC	NA	NA	1.3	7.98E-10	7.98E-10	0.13	NA	NA	0.13	8.04E-10	8.04E-10	1.60E-09	
Dichloroethene, cis-1,2-	0.0278	0.1	NA	NC	NA	NA	1	1.31E-10	1.31E-09	0.1	NA	NA	0.1	1.32E-10	1.32E-09	2.64E-09	
Dichloroethene, 1,1-	0.0278	0.05	NA	NC	NA	NA	1	1.31E-10	2.63E-09	0.1	NA	NA	0.1	1.32E-10	2.65E-09	5.27E-09	
Tetrachloroethene	0.989	0.1	0.051	1	3.34E-10	1.70E-11	1	4.67E-09	4.67E-08	0.1	3.36E-10	1.71E-11	0.1	4.71E-09	4.71E-08	9.38E-08	
Trans-1,2-Dichloroethene	0.0278	0.2	NA	NC	NA	NA	1	1.31E-10	6.57E-10	0.1	NA	NA	0.1	1.32E-10	6.61E-10	1.32E-09	
Trichloroethane, 1,1,1-	0.0767	0.9	NA	NC	NA	NA	1	3.62E-10	4.03E-10	0.1	NA	NA	0.1	3.65E-10	4.05E-10	8.08E-10	
Trichloroethene	0.358	0.02	0.011	1	1.21E-10	1.33E-12	1	1.69E-09	8.46E-08	0.1	1.22E-10	1.34E-12	0.1	1.70E-09	8.52E-08	1.70E-07	
Vinyl chloride	0.0278	0.003	1.4	1.53	1.44E-11	2.01E-11	1	1.31E-10	4.38E-08	0.16	1.51E-11	2.12E-11	0.1	1.32E-10	4.41E-08	8.79E-08	
Total						3.97E-11			2.13E-07			4.09E-11			2.15E-07	8.05E-11	4.28E-07

NA - Not available
NC - Not calculated
ND - Not detected

Table A-122
Exposure and Risk Estimates Associated With Inhalation of Soil-Derived Particulates in Air
50 Tufis Street, Somerville MA
Unifirst
Utility Worker in streets
Ambient Air

Receptor:	Utility Worker
Medium of Origin:	Soil
Exposure Medium:	Ambient Air
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

Parameter	Definition	Units	Value	Comment
IRair	Outdoor Air Inhalation Rate - Particulates	m3/hr	3.6	
IRairTWA	Outdoor Air TWA Inhalation Rate - Particulates	m3-y/h-kg	0.00	
PEF	Outdoor Air PM10 - Particulates	ug/m3	60	
ET	Outdoor Air Exposure Time - Particulates	hr/d	8	
EF	Outdoor Air Exposure Frequency - Particulates	d/y	1	
EP	Outdoor Air Exposure Period - Cancer - Particulates	y	5	
EP	Outdoor Air Exposure Period - Non-Cancer - Particulates	d	25550	
ATc	Outdoor Air Averaging Time - Cancer - Particulates	y	5	
ATn	Outdoor Air Averaging Time - Non-Cancer - Particulates	d	1825	
BW	Body Weight	kg	58.0	
C	Conversion Factor	ug/mg	1000	

$$C_{air} = C_{soil} \times PM_{10}$$
$$ADD_{inh-gi} = \frac{C_{air} \times 1.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADD_{inh} = \frac{C_{air} \times 0.5 \times IR_{air} \times RAF_i \times ET \times EF \times EP \times C}{AP \times BW}$$
$$ADE_{inh} = \frac{ADD_{inh} \times 70kg}{20m^3 / d}$$
$$HI = \frac{ADD_{inh-gi}}{RfD} + \frac{ADE_{inh}}{RfC}$$
$$Risk = (ADD_{inh-gi} \times CSF) + (ADE_{inh} \times URF \times C)$$

Compound	EPC Soil (mg/kg)	EPC Fugitive Dust (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	RAFc	ADD-inhc mg/kg-d	ADE-c mg/m3	Riskinh	ADD-ingc	Risking	RAFcnc	ADD-inhcnc mg/kg-d	ADE-cnc mg/m3	Hlinh	ADD-ingcnc	Hling	Risk (Particulates in Air) YC-OC-A	HI (Particulates in Air) YC
Carbon tetrachloride	2.78E-02	1.67E-09	0.43	0.000015	0.007	0.13	1	8.104E-14	2.836E-13	4.22E-15	2.431E-13	3.16E-14	1	1.13E-12	3.97E-12	9.24E-12	3.40E-12	4.86E-10	3.59E-14	4.95E-10
Chloroethane	5.55E-02	3.33E-09	10	NA	0.4	NA	NC	NA	NA	NA	NA	NA	1	2.27E-12	7.93E-12	7.93E-13	6.80E-12	1.70E-11	NA	1.78E-11
Chloroform	2.78E-02	1.67E-09	0.66	0.000023	0.01	NA	1	8.104E-14	2.836E-13	6.55E-15	NA	NA	1	1.13E-12	3.97E-12	6.02E-12	3.40E-12	3.40E-10	6.55E-15	3.46E-10
Dichloroethane, 1,1-	1.30E-01	7.80E-09	5	NA	1	NA	NC	NA	NA	NA	NA	NA	1	5.31E-12	1.86E-11	3.71E-12	1.59E-11	1.59E-11	NA	1.96E-11
Dichloroethane, cis-1,2-	2.78E-02	1.67E-09	0.035	NA	0.1	NA	1	NA	NA	NA	NA	NA	1	1.13E-12	3.97E-12	1.13E-10	3.40E-12	3.40E-11	NA	1.47E-10
Dichloroethane, 1,1-	2.78E-02	1.67E-09	0.2	NA	0.05	NA	1	NA	NA	NA	NA	NA	1	1.13E-12	3.97E-12	1.99E-11	3.40E-12	6.81E-11	NA	8.79E-11
Tetrachloroethene	9.89E-01	5.93E-08	4.6	0.00001	0.1	0.051	1	2.883E-12	1.009E-11	1.01E-13	8.649E-12	4.41E-13	1	4.04E-11	1.41E-10	3.07E-11	1.21E-10	1.21E-09	5.42E-13	1.24E-09
Trans-1,2-Dichloroethene	2.78E-02	1.67E-09	0.7	NA	0.2	NA	NC	NA	NA	NA	NA	NA	1	1.13E-12	3.97E-12	5.67E-12	3.40E-12	1.70E-11	NA	2.27E-11
Trichloroethane, 1,1,1-	7.67E-02	4.60E-09	5.2	NA	0.9	0.011	1	1.044E-12	3.653E-12	6.22E-15	3.131E-12	3.44E-14	1	3.13E-12	1.10E-11	2.11E-12	9.39E-12	1.04E-11	NA	1.25E-11
Trichloroethene	3.58E-01	2.15E-08	0.18	0.0000017	0.02	0.011	1	1.044E-12	3.653E-12	6.22E-15	3.131E-12	3.44E-14	1	1.48E-11	5.11E-11	2.84E-10	4.38E-11	2.19E-09	4.06E-14	2.48E-09
Vinyl chloride	2.78E-02	1.67E-09	0.1	0.0000088	0.003	1.4	1	8.104E-14	2.836E-13	2.44E-15	2.431E-13	3.40E-13	1	1.13E-12	3.97E-12	3.97E-11	3.40E-12	1.13E-09	3.43E-13	1.17E-09
Total										1.20E-13		8.48E-13				5.15E-10		5.53E-09	9.68E-13	6.04E-09

NA - Not available
NC - Not calculated
ND - Not detected

Table A-123
Exposure and Risk Estimates Associated With Groundwater Contact
50 Tufts Street, Somerville MA
UniFirst
Utility Worker in streets
Groundwater

Receptor:	Utility Worker
Medium:	Groundwater
Exposure Area:	Trench
Depth:	0-6 feet
Duration:	Subchronic

$$ADD_{ing} = \frac{C_{gw} \times IR_{gw} \times RAF_{gw} \times EF \times EP}{AP \times BW}$$

$$ADD_{der} = \frac{C_{gw} \times CF \times SA \times K_p \times ET \times RAF_{dw} \times EF \times EP}{AP \times BW}$$

$$HI_{ing} = \frac{ADD_{ing}}{RfD}$$

$$HI_{der} = \frac{ADD_{der}}{RfD}$$

$$HI = HI_{ing} + HI_{der}$$

$$Risk = ADD_{ing} \times CSF$$

$$Risk = ADD_{der} \times CSF$$

$$Risk = Risk_{ing} + Risk_{der}$$

Parameter	Definition	Units	Value	Comment
IRgw	Groundwater Ingestion Rate	L/d	0.01	
SA	Groundwater Dermal Contact Skin Exposed	cm2	817	
EF	Groundwater Exposure Frequency	d/y	1	
EP	Groundwater Exposure Period - Cancer	y	5	
EP	Groundwater Exposure Period - Non-Cancer	y	5	
ATc	Groundwater Averaging Time - Cancer	d	25550	
ATn	Groundwater Averaging Time - Non-Cancer	d	1825	
ET	Groundwater Dermal Contact Exposure Time	hr/d	2	
BW	Body Weight	kg	58	
CF	Conversion Factor	L/cm3	1.00E-03	

Compound	EPC Groundwater (mg/L)	RfD (mg/kg-d)	CSF 1/(mg/kg-d)	Incidental Ingestion RAFowc	ADDing-c mg/kg-d	Risking	RAFownc	ADDing-nc mg/kg-d	Hling	Dermal Contact Kp (cm/hr)	RAFdw	ADDder-c mg/kg-d	Riskder	RAFdwc	ADDder-nc mg/kg-d	Hlder	Total Risk(GW)	HI(GW)
Carbon tetrachloride	0.0005	0.007	0.13	1	1.69E-11	2.19E-12	1	2.36E-10	3.37E-08	0.0160472	1	4.42E-11	5.75E-12	1	6.19E-10	8.85E-08	7.94E-12	1.22E-07
Chloroethane	0.001	0.4	NA	NC	NA	NA	1	4.72E-10	1.18E-09	0.0060602	NC	NA	NA	1	4.68E-10	1.17E-09	NA	2.35E-09
Chloroform	0.01275	0.01	NA	NC	NA	NA	1	6.02E-09	6.02E-07	0.0068	NC	NA	NA	1	6.69E-09	6.69E-07	NA	1.27E-06
Dichloroethane, 1,1-	0.0494	1	NA	NC	NA	NA	1.3	3.03E-08	3.03E-08	0.0067143	NC	NA	NA	1	2.56E-08	2.56E-08	NA	5.59E-08
Dichloroethane, cis-1,2-	0.06565	0.1	NA	NC	NA	NA	1	3.10E-08	3.10E-07	0.0065826	NC	NA	NA	1	3.34E-08	3.34E-07	NA	6.44E-07
Dichloroethane, 1,1-	0.029316667	0.05	NA	NC	NA	NA	1	1.38E-08	2.77E-07	0.0043013	NC	NA	NA	1	9.73E-09	1.95E-07	NA	4.72E-07
Tetrachloroethene	12.47	0.1	0.051	1	4.21E-07	2.15E-08	1	5.89E-06	5.89E-05	0.0326889	1	2.25E-06	1.15E-07	1	3.15E-05	3.15E-04	1.36E-07	3.74E-04
Trans-1,2-Dichloroethene	0.01275	0.2	NA	NC	NA	NA	1	6.02E-09	3.01E-08	0.0108693	NC	NA	NA	1	1.07E-08	5.35E-08	NA	8.36E-08
Trichloroethane, 1,1,1-	0.09195	0.9	NA	NC	NA	NA	1	4.34E-08	4.83E-08	0.0125487	NC	NA	NA	1	8.91E-08	9.90E-08	NA	1.47E-07
Trichloroethene	0.1415	0.02	0.011	1	4.77E-09	5.25E-11	1	6.68E-08	3.34E-06	0.0115771	1	9.03E-09	9.93E-11	1	1.26E-07	6.32E-06	1.52E-10	9.66E-06
Vinyl chloride	0.01275	0.003	1.4	1.53	6.58E-10	9.21E-10	1	6.02E-09	2.01E-06	0.008249	1	5.80E-10	8.12E-10	1	8.12E-09	2.71E-06	1.73E-09	4.71E-06
Total						2.24E-08		6.56E-05					1.16E-07			3.25E-04	1.38E-07	3.91E-04

NA - Not available
NC - Not calculated
ND - Not detected
Assumes gw is at bottom of trench (~6')

Table A-124
Volatilization Factors
50 Tufts Street, Somerville MA
UniFirst
Utility Worker in streets

Compound	Henry's Law Constant at Avg GW Temp (conc/conc) H ^o _{TS}	Deff Vadose Zone (Layer A + Layer B)	Deff Total (Layer A + Layer B + Layer C)	Deffcrack (Layer A)	Exponent of Peclet Number	Organic Carbon- Water Partition Coefficient K _{oc}	Volatilization from Subsurface Soil to Excavation Air VF (mg/m3) / (mg/kg)	Volatilization from Subsurface Soil to Trench Air VF (mg/m3) / (mg/kg)	Volatilization from Soil Gas to Excavation Air Alpha (mg/m3 excav) / (mg/m3 SG)	Volatilization from Soil Gas to Trench Air Alpha (mg/m3 trench) / (mg/m3 SG)	Volatilization from Groundwater to Excavation Air VF (mg/m3) / (mg/L)	Volatilization from Groundwater to Trench Air VF (mg/m3) / (mg/L)
Carbon tetrachloride	5.88E-01	1.54E-02	7.49E-03	1.54E-02	1.28E+104	152	1.53E-03	5.88E-02	-1.69E-06	3.51E-04	-4.84E-04	1.00E-01
Chloroethane	4.77E-01	5.35E-02	2.60E-02	5.35E-02	9.20E+29	23.74	5.80E-03	2.23E-01	-5.88E-06	1.22E-03	-1.36E-03	2.82E-01
Chloroform	8.04E-02	2.05E-02	1.00E-02	2.05E-02	1.20E+78	52.5	1.11E-03	4.28E-02	-2.26E-06	4.67E-04	-8.84E-05	1.83E-02
Dichloroethane, 1,1-	1.24E-01	1.46E-02	7.13E-03	1.46E-02	2.74E+109	53.4	1.15E-03	4.43E-02	-1.61E-06	3.33E-04	-9.75E-05	2.02E-02
Dichloroethane, cis-1,2-	8.79E-02	1.45E-02	7.08E-03	1.45E-02	2.13E+110	35.5	1.17E-03	4.51E-02	-1.60E-06	3.31E-04	-6.85E-05	1.42E-02
Dichloroethane, 1,1-	6.34E-01	1.78E-02	8.64E-03	1.78E-02	1.68E+90	65	2.51E-03	9.62E-02	-1.95E-06	4.04E-04	-6.03E-04	1.25E-01
Tetrachloroethene	3.24E-01	1.42E-02	6.91E-03	1.42E-02	6.04E+112	265	8.42E-04	3.23E-02	-1.56E-06	3.24E-04	-2.47E-04	5.11E-02
Trans-1,2-Dichloroethene	2.13E-01	1.40E-02	6.79E-03	1.40E-02	7.16E+114	38	1.71E-03	6.55E-02	-1.53E-06	3.18E-04	-1.59E-04	3.30E-02
Trichloroethane, 1,1,1-	3.66E-01	1.54E-02	7.49E-03	1.54E-02	1.28E+104	135	1.29E-03	4.95E-02	-1.69E-06	3.51E-04	-3.01E-04	6.24E-02
Trichloroethene	1.97E-01	1.56E-02	7.59E-03	1.56E-02	6.13E+102	94.3	1.14E-03	4.38E-02	-1.71E-06	3.55E-04	-1.65E-04	3.41E-02
Vinyl chloride	7.65E-01	2.09E-02	1.02E-02	2.09E-02	4.04E+76	18.6	4.71E-03	1.81E-01	-2.30E-06	4.76E-04	-8.56E-04	1.77E-01

Utility Worker in streets

Select soil type in vadose zone and capillary zone:

Vadose zone adjacent to building

Sand

Capillary zone

Sand

Key:

Type in Site-specific values here

Calculated values

Constants

Default parameter values from DEP

Symbol	(units)	Parameter	Value	Comment																																								
L _{crack}	(cm)	Thickness of foundation	15.0																																									
f _{oc}	(g/g)	Fraction organic carbon in vadose zone soil	0.02																																									
L _f	(15 or 200 cm)	Depth below grade to bottom of enclosed space floor	15	Input either 15 or 200																																								
L _{wt}	(cm)	Depth below grade to water table	187.7568	6.16 Ft.																																								
T _s	Kelvin	Average soil/ groundwater temperature	283.15	10 (°C)																																								
L _t	(cm)	Source- building separation	172.7568																																									
L _g	(cm)	Length of building	961	DEP Default																																								
W _g	(cm)	Width of building	961	DEP Default																																								
H _g	(cm)	Height of building	488	DEP Default																																								
X _{crack}	(cm)	Floor- wall seam perimeter	3844.00																																									
ER	(1/hr)	Air exchange rate	0.45	DEP Default																																								
Q _{building}	(cm³/s)	Bldg. ventilation rate	56334.781																																									
A _g	(cm²)	Area of enclosed space below grade	923521																																									
η	(unitless)	Crack- to-total area ratio	0.000416233																																									
Z _{crack}	(cm)	Crack depth below grade	15.0																																									
μ _{TS}	(g/cm-s)	Vapor viscosity at ave. soil temperature	0.000175414																																									
L _d	(cm)	Diffusion path length	172.7568																																									
L _p	(cm)	Convection path length	15																																									
r _{crack}	(cm)	Crack radius	0.10	DEP Default																																								
ΔP	g/cm-s2	Pressure differential between soil surface and enclosed space	40.00	DEP Default																																								
Q _{soil}	(cm³/s)	Average vapor flow rate into bldg.	9.454788E+01																																									
A _{crack}	(cm²)	Area of crack	384.4																																									
R _c	(cal/mol-K)	Gas constant	1.9872																																									
R	(atm-m3/mol-K)	Universal gas constant	0.00009205																																									
R2	(mm-Hg-cm3/mol-K)	Universal gas constant	62361																																									
W _{SA}	(cm)	Width of soil source to ambient air	1524	50 Ft.																																								
t _{SA}	(s)	Averaging time for volatilization from soil to ambient air	441504	0.014 y																																								
U	(cm/s)	Wind speed	225																																									
D	(cm)	Mixing height	182.88	6 Ft.																																								
Z _s	(cm)	Depth to soil source	187.7568	6.16 Ft.																																								
Z _{sg}	(cm)	Depth to soil gas source	187.7568	6.16 Ft.																																								
W _E	(cm)	Width of excavation	1524	50 Ft.																																								
L _E	(cm)	Length of excavation	762	25 Ft.																																								
H _E	(cm)	Height of excavation	457.2	15 Ft.																																								
W _{Ec}	(cm)	Width of excavation that is contaminated	1524	50 Ft.																																								
L _{Ec}	(cm)	Length of excavation that is contaminated	762	25 Ft.																																								
H _{Ec}	(cm)	Height of excavation that is contaminated	457.2	15 Ft.																																								
WT	(cm)	Width of trench	457.2	15 Ft.																																								
LT	(cm)	Length of trench	121.92	4 Ft.																																								
HT	(cm)	Height of trench	182.88	6 Ft.																																								
W _{Tc}	(cm)	Width of trench that is contaminated	457.2	15 Ft.																																								
L _{Tc}	(cm)	Length of trench that is contaminated	121.92	4 Ft.																																								
H _{Tc}	(cm)	Height of trench that is contaminated	182.88	6 Ft.																																								
t _{SE}	(s)	Averaging time for volatilization from soil to excavation	15768000	0.5 y																																								
t _{ST}	(s)	Averaging time for volatilization from soil to trench	441504	0.014 y																																								
F _E	(unitless)	Fraction of wind speed that occurs in excavation	0.5																																									
F _I	(unitless)	Fraction of wind speed that occurs in trench	0.1																																									
d	(cm)	Lower depth of surface soil source	482.0768	15.16 Ft.																																								
<table><tr><td colspan="2">Vadose Zone Layer A</td><td>Vadose Zone Layer B</td><td>Capillary Zone</td></tr><tr><td>1.5</td><td>1.5</td><td>1.5</td><td>1.5</td></tr><tr><td></td><td>0.43</td><td>0.43</td><td>0.43</td></tr><tr><td>0.06</td><td></td><td>0.06</td><td>0.253258113</td></tr><tr><td>0.37</td><td></td><td>0.37</td><td>0.176741887</td></tr><tr><td>15</td><td></td><td>140.7113455</td><td>17.04545455</td></tr><tr><td></td><td></td><td></td><td>0.018567639</td></tr><tr><td></td><td></td><td></td><td>9.92425E-08</td></tr><tr><td></td><td></td><td></td><td>0.986637033</td></tr><tr><td></td><td></td><td></td><td>9.79183E-08</td></tr></table>					Vadose Zone Layer A		Vadose Zone Layer B	Capillary Zone	1.5	1.5	1.5	1.5		0.43	0.43	0.43	0.06		0.06	0.253258113	0.37		0.37	0.176741887	15		140.7113455	17.04545455				0.018567639				9.92425E-08				0.986637033				9.79183E-08
Vadose Zone Layer A		Vadose Zone Layer B	Capillary Zone																																									
1.5	1.5	1.5	1.5																																									
	0.43	0.43	0.43																																									
0.06		0.06	0.253258113																																									
0.37		0.37	0.176741887																																									
15		140.7113455	17.04545455																																									
			0.018567639																																									
			9.92425E-08																																									
			0.986637033																																									
			9.79183E-08																																									
P ₀	(g/cm³)	Vadose zone soil dry bulk density																																										
n	(unitless)	Vadose zone soil total porosity																																										
θ _w	(cm³/cm³)	Vadose zone soil water-filled porosity																																										
θ _a	(cm³/cm³)	Vadose zone soil air-filled porosity																																										
h	(cm)	Thickness of soil layer																																										
S _{we}	(cm³/cm³)	Vadose zone effective total fluid saturation																																										
k _i	(cm²)	Vadose zone soil intrinsic permeability																																										
k _{ra}	(cm²)	Vadose zone soil relative air permeability																																										
k _v	(cm²)	Vadose zone soil effective vapor permeability																																										

Values Assume all sources are 1 inch below excavation depth

Table A-126

Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA

UniFirst

Utility Worker in streets

Trench Air

Volatilization from Soil Gas

Receptor:	Utility Worker	▼
Medium of Origin:	Soil Gas	▼
Exposure Medium:	Trench Air	▼
Exposure Area:	Trench	▼
Depth:	0-6 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Soil Gas mg/m3	Alpha Volatilization from Soil Gas to Trench Air (mg/m3 trench) / (mg/m3 SG)	Source Dilution Factor	EPC Trench Air (mg/m3)	RIC (mg/m3)	URF 1/(ug/m3)	RAFiC	ADE-c mg/m3	Riskinh	RAFiC	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	0.865416667	3.51E-04	1	3.03E-04	0.43	0.000015	1	1.98E-08	2.97E-10	1	2.77E-07	6.44E-07	2.97E-10	6.44E-07
Chloroethane	0.36475	1.22E-03	1	4.44E-04	10	NA	NC	NA	NA	1	4.05E-07	4.05E-08	NA	4.05E-08
Chloroform	NA	4.67E-04	1	NA	0.66	0.000023	1	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1-	0.803666667	3.33E-04	1	2.68E-04	5	NA	NC	NA	NA	1	2.45E-07	4.89E-08	NA	4.89E-08
Dichloroethene, cis-1,2-	0.5479	3.31E-04	1	1.81E-04	0.035	NA	NC	NA	NA	1	1.66E-07	4.73E-06	NA	4.73E-06
Dichloroethene, 1,1-	1.312	4.04E-04	1	5.31E-04	0.2	NA	1	NA	NA	1	4.85E-07	2.42E-06	NA	2.42E-06
Tetrachloroethene	332.1	3.24E-04	1	1.07E-01	4.6	0.00001	1	7.01E-06	7.01E-08	1	9.81E-05	2.13E-05	7.01E-08	2.13E-05
Trans-1,2-Dichloroethene	0.000395	3.18E-04	1	1.26E-07	0.7	NA	NC	NA	NA	1	1.15E-10	1.64E-10	NA	1.64E-10
Trichloroethane, 1,1,1-	3.6585	3.51E-04	1	1.28E-03	5.2	NA	NC	NA	NA	1	1.17E-06	2.25E-07	NA	2.25E-07
Trichloroethene	1.934333333	3.55E-04	1	6.87E-04	0.18	0.0000017	1	4.48E-08	7.62E-11	1	6.27E-07	3.48E-06	7.62E-11	3.48E-06
Vinyl chloride	0.352666667	4.76E-04	1	1.68E-04	0.1	0.0000088	1	1.10E-08	9.64E-11	1	1.53E-07	1.53E-06	9.64E-11	1.53E-06
Total									7.06E-08			3.45E-05	7.06E-08	3.45E-05

NA - Not available

NC - Not calculated

ND - Not detected

Table A-127
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker in streets
Trench Air
Volatilization from Subsurface Soil

Receptor:	Utility Worker	▼
Medium of Origin:	Subsurface Soil	▼
Exposure Medium:	Trench Air	▼
Exposure Area:	Trench	▼
Depth:	0-6 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha) \times SDF}{C_{air} \times RAF_i \times ET \times EF \times EP}$$
$$ADE_{inh} = \frac{C_{air}}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$
$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$
$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	VF Volatilization from Subsurface Soil to Trench Air (mg/m3) / (mg/kg)	Source Dilution Factor	EPC		URF	Risk		HI (Trench Air)
				Trench Air	RIC (mg/m3)		RAFiC	ADE-c mg/m3	
Carbon tetrachloride	0.0278	5.88E-02	1	1.63E-03	0.43	0.000015	1	1.07E-07	1.60E-09
Chloroethane	0.0555	2.23E-01	1	1.24E-02	10	NA	NC	NA	NA
Chloroform	0.0278	4.28E-02	1	1.19E-03	0.66	0.000023	1	7.76E-08	1.78E-09
Dichloroethane, 1,1-	0.13	4.43E-02	1	5.76E-03	5	NA	NC	NA	NA
Dichloroethane, cis-1,2-	0.0278	4.51E-02	1	1.25E-03	0.035	NA	NC	NA	NA
Dichloroethane, 1,1-	0.0278	9.62E-02	1	2.68E-03	0.2	NA	1	NA	NA
Tetrachloroethene	0.989	3.23E-02	1	3.20E-02	4.6	0.00001	1	2.09E-06	2.09E-08
Trans-1,2-Dichloroethene	0.0278	6.55E-02	1	1.82E-03	0.7	NA	NC	NA	NA
Trichloroethane, 1,1,1-	0.0767	4.95E-02	1	3.79E-03	5.2	NA	NC	NA	NA
Trichloroethene	0.358	4.38E-02	1	1.57E-02	0.18	0.0000017	1	1.02E-06	1.74E-09
Vinyl chloride	0.0278	1.81E-01	1	5.03E-03	0.1	0.0000088	1	3.28E-07	2.89E-09
Total									

NA - Not available
NC - Not calculated
ND - Not detected

Table A-128
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker in streets
Trench Air
Volatilization from Groundwater

Receptor:	Utility Worker
Medium of Origin:	Groundwater
Exposure Medium:	Trench Air
Exposure Area:	Trench
Depth:	0-15 feet
Duration:	Subchronic

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24 \text{ hr} / d \times 365 \text{ d} / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC Groundwater (mg/L)	VF Volatilization from Groundwater to Trench Air (mg/m3) / (mg/L)	Source Dilution Factor	EPC Trench Air (mg/m3)	RfC (mg/m3)	URF 1/(ug/m3)	RAFic mg/m3	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	5.00E-04	1.00E-01	1	5.02E-05	0.43	0.000015	1	3.27E-09	4.91E-11	1	4.58E-08	1.07E-07	4.91E-11	1.07E-07
Chloroethane	0.001	2.82E-01	1	2.82E-04	10	NA	NC	NA	NA	1	2.58E-07	2.58E-08	NA	2.58E-08
Chloroform	0.01275	1.83E-02	1	2.34E-04	0.66	0.000023	1	1.52E-08	3.50E-10	1	2.13E-07	3.23E-07	3.50E-10	3.23E-07
Dichloroethane, 1,1-	0.0494	2.02E-02	1	9.98E-04	5	NA	NC	NA	NA	1	9.11E-07	1.82E-07	NA	1.82E-07
Dichloroethane, cis-1,2-	0.06565	1.42E-02	1	9.32E-04	0.035	NA	NC	NA	NA	1	8.51E-07	2.43E-05	NA	2.43E-05
Dichloroethane, 1,1,1-	0.029316667	1.25E-01	1	3.66E-03	0.2	NA	1	NA	NA	1	3.34E-06	1.67E-05	NA	1.67E-05
Tetrachloroethene	12.47	5.11E-02	1	6.37E-01	4.6	0.00001	1	4.15E-05	4.15E-07	1	5.82E-04	1.26E-04	4.15E-07	1.26E-04
Trans-1,2-Dichloroethene	0.01275	3.30E-02	1	4.21E-04	0.7	NA	NC	NA	NA	1	3.84E-07	5.49E-07	NA	5.49E-07
Trichloroethane, 1,1,1-	0.09195	6.24E-02	1	5.74E-03	5.2	NA	NC	NA	NA	1	5.24E-06	1.01E-06	NA	1.01E-06
Trichloroethene	0.1415	3.41E-02	1	4.83E-03	0.18	0.000017	1	3.15E-07	5.35E-10	1	4.41E-06	2.45E-05	5.35E-10	2.45E-05
Vinyl chloride	0.01275	1.77E-01	1	2.26E-03	0.1	0.0000088	1	1.47E-07	1.30E-09	1	2.06E-06	2.06E-05	1.30E-09	2.06E-05
Total									4.18E-07			2.15E-04	4.18E-07	2.15E-04

NA - Not available
NC - Not calculated
ND - Not detected

Table A-129
Exposure and Risk Estimates Associated With Inhalation of Volatile Compounds in Air
50 Tufts Street, Somerville MA
UniFirst
Utility Worker in streets
Trench Air

Receptor:	Utility Worker	▼
Medium of Origin:		▼ All 3 media
Exposure Medium:	Trench Air	▼
Exposure Area:	Trench	▼
Depth:	0-6 feet	▼
Duration:	Subchronic	▼

$$C_{air} = \frac{C_{source} \times (VF \text{ or } \alpha)}{SDF}$$

$$ADE_{inh} = \frac{C_{air} \times RAF_i \times ET \times EF \times EP}{24hr / d \times 365 d / y \times AT}$$

$$HI_{inh} = \frac{ADE_{inh}}{RfC}$$

$$Risk = ADE_{inh} \times URF \times C$$

Parameter	Definition	Units	Value	Comment
ET	Outdoor Air Exposure Time - Volatiles	hr/d	8	
EF	Outdoor Air Exposure Frequency - Volatiles	d/y	1	
EP	Outdoor Air Exposure Period - Non-Cancer - Volatiles	y	5	
EP	Outdoor Air Exposure Period - Cancer - Volatiles	y	5	
ATc	Outdoor Air Averaging Time - Cancer - Volatiles	d	25550	
ATn	Outdoor Air Averaging Time - Non-Cancer - Volatiles	d	1825	
C	Conversion Factor	ug/mg	1000	

Compound	EPC	RfC (mg/m3)	URF 1/(ug/m3)	RAFic	ADE-c mg/m3	Riskinh	RAFinc	ADE-nc mg/m3	Hlinh	Risk (Trench Air)	HI (Trench Air)
Carbon tetrachloride	6.63E-04	0.43	0.000015	1	4.32E-08	6.48E-10	1	6.05E-07	1.41E-06	6.48E-10	1.41E-06
Chloroethane	4.36E-03	10	NA	NC	NA	NA	1	3.98E-06	3.98E-07	NA	3.98E-07
Chloroform	7.11E-04	0.66	0.000023	1	4.64E-08	1.07E-09	1	6.50E-07	9.84E-07	1.07E-09	9.84E-07
Dichloroethane, 1,1-	NA	5	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethane, cis-1,2-	NA	0.035	NA	NC	NA	NA	1	NA	NA	NA	NA
Dichloroethane, 1,1,1-	NA	0.2	NA	1	NA	NA	1	NA	NA	NA	NA
Tetrachloroethene	2.59E-01	4.6	0.00001	1	1.69E-05	1.69E-07	1	2.36E-04	5.14E-05	1.69E-07	5.14E-05
Trans-1,2-Dichloroethene	7.48E-04	0.7	NA	NC	NA	NA	1	6.83E-07	9.75E-07	NA	9.75E-07
Trichloroethane, 1,1,1-	3.60E-03	5.2	NA	NC	NA	NA	1	3.29E-06	6.33E-07	NA	6.33E-07
Trichloroethene	7.06E-03	0.18	0.0000017	1	4.61E-07	7.83E-10	1	6.45E-06	3.58E-05	7.83E-10	3.58E-05
Vinyl chloride	2.49E-03	0.1	0.0000088	1	1.62E-07	1.43E-09	1	2.27E-06	2.27E-05	1.43E-09	2.27E-05
Total						1.73E-07			1.14E-04	1.73E-07	1.14E-04

NA - Not available
NC - Not calculated
ND - Not detected
Assumes groundwater is directly beneath the excavation

ATTACHMENT B

DESCRIPTION OF AMBIENT AIR VOLATILIZATION MODEL (EXCAVATION/TRENCH)

Description of the Volatilization Model into Trench/Excavation

ASTM (1995) presented a series of simple models for calculating the equilibrium concentration of volatile compounds in ambient air above soil or groundwater sources. These equations were based on flux to the surface produced by assumed molecular diffusion of volatile compounds through porosities in soil into a “box” of air. Loading of the box is countered by wind movement through the box. Molecular diffusion occurs down a concentration gradient, and it is assumed in each of these models that the concentration of volatile compounds in the ambient air box is so low relative to the soil vapour concentration at the source as to be equivalent to zero.

ASTM provided basic equations for calculating “volatilization factors” (VF), which, when multiplied by a site-specific media concentration (groundwater or soil concentration) will produce an estimate of ambient air concentration. The VF algorithms are:

$$VF_{ss} = \frac{W \times C \times 2 \times B \left(\frac{D_{eff} \times H}{\sqrt{\pi \times (E_m + k_{oc} \times foc \times B + E_v \times H) \times t}} \right)}{U_{air} \times \delta_{air}}$$

Equation 1

$$VF_{samb} = \frac{H \times B}{(E_m + k_{oc} \times foc \times B + E_v \times H) \times (1 + (U_{air} \times \delta_{air} \times z / (D_{eff} \times W)))}$$

Equation 2

$$VF_{wamb} = \frac{H \times C}{1 + (U_{air} \times \delta_{air} \times z / (W \times D_{eff}))}$$

Equation 3

The volatilization factors VF_{ss} , VF_{samb} , and VF_{wamb} in Equations 1-3 are used to estimate ambient air concentrations from surface soil sources, soil sources beneath a clean cover of thickness z , and from groundwater at z depth below ground surface, respectively.

In order to estimate volatile concentrations in a trench, slight modifications of the VF terms described above are required. The most significant modification to the model for volatilization from soils at the surface of a trench or other excavation, was to account for the potential sources in the side walls. The basis assumption is that the hypothetical box of air mentioned above could now be described by the dimensions (or a portion of the dimensions) of the trench or excavation in which the receptors were assumed to be exposed (the dimensions of the subsurface space would also affect proximity to the source). Further, because the airspace is below ground surface, one would not expect wind clearance of air to be as efficient. Accordingly, a term producing a decrement in wind speed is added. The resulting equations are:

$$VF_{trench} = \frac{(W_c \times L_c + 2 \times L_c \times D_c + 2 \times W_c \times D_c) \times C \times 2 \times B \left(\frac{D_{eff} \times H}{\sqrt{\pi \times (E_m + k_{oc} \times foc \times B + E_v \times H) \times t}} \right)}{V_t \times A}$$

Equation 4

Where:

$$D_{eff} = \frac{Da \times Em^{3.33}}{(Et^2)} + \frac{Dw \times Em^{3.33}}{(H * Et^2)}$$

$$A = (U * L * D * Ft) / Vt$$

W: Trench width in downwind direction (cm)

D: Depth of trench (cm)

L: Length of trench transverse to the wind (cm)

Vt: Volume of trench (cm³)

Wc: Length of contamination in width direction (cm)

Dc: Length of contamination in height direction (cm)

Lc: Length of contamination in length direction (cm)

C: Conversion factor (cm³-kg/m³-g)

Deff: Effective molecular diffusion through soil (cm²/s)

H: Henry's Law Coefficient (cm³-water/cm³-air)

B: Soil bulk density (g/cm³)

Em: Water-filled soil porosity (unitless)

Ev: Air-filled soil porosity (unitless)

Et: Total soil porosity

Koc: organic carbon-water sorption coefficient (cm³-water/g-carbon)

Foc: Fraction organic carbon

t: averaging time for flux (s)

U: Mean annual wind speed (cm/s)

Ft: Fraction of mean annual wind speed that occurs in trench

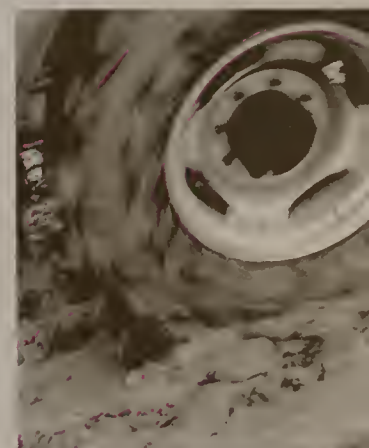
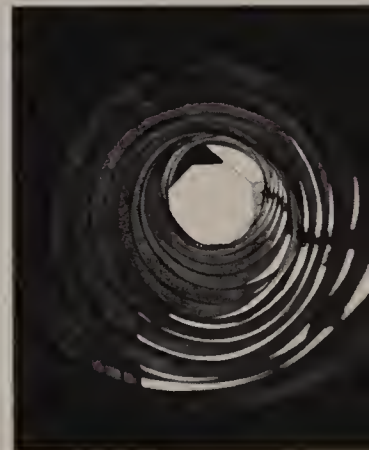
A: air exchange rate (s⁻¹)

Da: Molecular diffusion constant in air (cm²/s)

Dw: Molecular diffusion constant in water (cm²/s)



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Appendix O

RAA Cost Estimate Information

Appendix O

RAA Cost Estimate Information

Cost estimates were developed based on the conceptual RAA designs described in Section 13. Cost estimates were developed from our experience at similar sites. Tables O-1 through O-5 show costs for RAA1 through RAA5. Significant assumptions for each RAA are described below:

Global Assumptions (apply to all cost estimates)

- RAA development was based on information reported for the Tufts Street Site in Somerville, Massachusetts.
- Contractor costs include labor, materials, expenses, and overhead and profit.
- Preconstruction Professional Labor costs include design, contracts and specifications, construction supervision, project management, work plans, health and safety plans, sampling plans, and associated MCP reporting. Professional Labor costs associated with EPEMs were not included in the Professional Labor category because they were included in the line for EPEMs.
- EPEM costs include design, installation, and AUL for each location. A total of 47 locations were assumed.
- A contingency of 30 percent was applied to account for uncertainties associated with the conceptual-level capital cost estimates. This contingency was applied to costs for future remedial installations and was not applied to remedial systems already installed.
- A contingency of 20 percent was applied to account for uncertainties associated with the conceptual-level operation and maintenance cost estimates.
- A 5% discount factor was applied to future costs.
- A 30-year term was assumed for long term monitoring, operation, and maintenance activities even if the anticipated term was greater than 30 years, such as the expected 100 to 150 year duration of several RAAs. The net present value of monitoring and O&M costs incurred beyond 30 years is low and does not have a significant effect on total net present value costs.
- All costs are reported in 2008 dollars. Costs related to obtaining access rights, legal fees, or potential business disruption were not included.
- Annual groundwater monitoring would consist of an annual sampling round of 20 wells for 30 years and includes associated reporting.

- EPEM O&M and sampling cost include electrical reimbursements for blower operation, annual inspection of systems, two air samples for each location, and reporting.
- SSDS O&M costs include monthly inspection and electrical costs.

RAA1 – Site-wide EPEMs

- Professional labor costs for the 50 Tufts Street and the Capuano School SSDS are based on completed costs.
- Both systems were assumed to operate 30 years.
- SSDS air sampling for both Capuano and 50 Tufts Street was assumed to be semi-annual for the first five years, then annual for the next 25 years. Sampling consists of 12 air samples from each location and analysis for VOCs.

RAA2 –SVE and Site-wide EPEMs

- Professional labor and installation costs for the SSDS and SVE systems are based on completed costs.
- The SVE system was assumed to operate for four years and the SSDS was assumed to operate for 30 years.
- SSDS/SVE O&M costs include monthly inspection and electrical costs. Semi-annual carbon replacement costs were included for the SVE system.
- SSDS air sampling for both Capuano and 50 Tufts Street was assumed to be semi-annual for the first five years, then annual for the next 25 years. Sampling consists of 12 air samples from each location and analysis for VOCs.
- Semi-annual SVE air sampling costs was assumed to consist of 8 samples for VOC analysis.

RAA3 –Dual Phase Extraction, Monitored Natural Attenuation, and Downgradient EPEMs

- Remedial Design and Preconstruction Professional Labor costs were assumed to be 15 percent of total capital costs.
- The DPE system was assumed to operate for ten years
- At each pump location, a knockout tank in an enclosed shed would separate the groundwater from vapor and a separate pump would transfer the groundwater to the treatment building.
- A treatment system building would be installed either on, or close to, the 50 Tufts Street property. \$600,000 was included for either purchasing or leasing land for the building. \$300,000 was included for building construction.

- Treatment system O&M costs assume a full-time operator, electrical costs, annual carbon changeout costs, and disposal costs for approximately 140 tons of waste liquor from the scrubbers.
- A quarterly sampling program consisting of 20 groundwater and 10 soil vapor or air samples would be conducted during the remediation.
- EPEMs for residences in the treatment area (17, 19, and 23 Tufts Street) would be discontinued after the remediation has been completed.
- The 50 Tufts Street SSDS would be operational during remediation. The Capuano School system would operate for 30 years.
- SSDS air sampling for both Capuano and 50 Tufts Street was assumed to be semi-annual for the first five years, then annual thereafter. Sampling consists of 12 air samples from each location and analysis for VOCs.

RAA4 – Chemical Oxidation, Monitored Natural Attenuation, and Downgradient EPEMs

- Remedial Design and Preconstruction Professional Labor costs were assumed to be 15 percent of total capital costs.
- A skid mounted system would be used to administer 830,000 pounds of persulfate over two injection periods within approximately one year. Each injection period was assumed to last approximately 60 days.
- A quarterly sampling program consisting of 20 groundwater and 10 soil vapor or air samples would be conducted during the remediation.
- EPEMs for residences in the treatment area (17, 19, and 23 Tufts Street) would be discontinued after the remediation has been completed.
- The 50 Tufts Street SSDS would be operational during remediation only. The Capuano School system would operate for 30 years.
- SSDS air sampling for the Capuano SSDS was assumed to be semi-annual for the first five years, then annual thereafter. Sampling consists of 12 air samples from each location and analysis for VOCs. SSDS sampling was assumed to be semi-annual at 50 Tufts Street.

RAA5 – Hydraulic Containment, Monitored Natural Attenuation, and Downgradient EPEMs

- Remedial Design and Preconstruction Professional Labor costs were assumed to be 15 percent of total capital costs.

- A treatment system building would be installed either on or close to the 50 Tufts Street property. \$600,000 was included for either purchasing or leasing land for the building. \$300,000 was included for building construction.
- Treatment system O&M costs assume a part-time operator, electrical costs, annual carbon changeout costs, and disposal costs for approximately 47 tons of waste liquor from the scrubbers.
- Both SSD systems were assumed to operate for 30 years.
- SSDS air sampling for both Capuano and 50 Tufts Street was assumed to be semi-annual for the first five years, then annual for the next 25 years. Sampling consists of 12 air samples from each location and analysis for VOCs.
- A NPDES permit would be required for the groundwater discharge. However, an air permit is not expected be required for the wet scrubber discharge.

Table O-1
RAA1 - Site-wide EPEMs
50 Tufts Street
Somerville, Massachusetts

Activity	Cost Basis	Capital Cost	O&M Cost (Present Value)
A. Preconstruction Professional Labor	Engineering Design (Excluding EPEMs) Plans, Specifications, Bids, Regulatory Submittals, Site Survey	\$100,000	
B. Construction Management	Resident Engineer/Project Management	\$45,000	
C. 50 Tufts Street Subsurface Depressurization System	Installation of 22 sub-slab extraction points, 15 HP blower, and associated piping.	\$180,000	
D. Capuano School Subsurface Depressurization System	Installation of 18 sub-slab extraction points, 1.5 HP blower, and associated piping.	\$70,000	
E. Exposure Point Elimination Measures	Installation of EPEMs in 47 residences (includes design and AULs for each residence).	\$3,375,000	
F. Site-Wide Activity and Use Limitation	Preparation of Site-wide AUL.	\$75,000	
G. Groundwater Monitoring and Reporting	Annual sampling and VOC analysis for 20 groundwater wells for 30 years.		\$322,000
H. Residential EPEM O&M and Sampling Cost	Annual air sampling (2 samples per house) and reporting, blower electrical cost, and EPEM inspection for 30 years.		\$1,639,000
I. Subsurface Depressurization System O&M Cost	Monthly inspection of SSDS systems and electrical cost for 30 years		\$419,000
J. Subsurface Depressurization System Air Sampling Cost	Collection of 12 air samples each from 50 Tufts Street and Capuano School Subsurface Depressurization Systems for 30 years. Sampling is semi-annual for the first 5 years, then annual thereafter.		\$415,000
Subtotal Costs		\$3,845,000	\$2,795,000
Contingency on Capital Costs, 30%		\$1,035,000	
Contingency on O&M Costs, 20%		\$559,000	
Total Project Cost		\$8,234,000	

General Notes:

1. The costs provided here are estimates only and are based on our professional experience. Actual costs may be higher or lower depending on contractor quotes.
2. Quantities and design details such listed in this cost basis were estimated based on a conceptual design of the remedial option at the 50 Tufts Street site. Actual quantities and design details will vary based on the final design.
3. A 5% discount factor was used.

Table O-2
RAA2 –SVE and Site-wide EPEMs
50 Tufts Street
Somerville, Massachusetts

Activity	Cost Basis	Capital Cost	O&M Cost - (Present Value)
A. Preconstruction Professional Labor	Engineering Design (Excluding EPEMs) Plans, Specifications, Bids, Regulatory Submittals, Site Survey	\$125,000	
B. Construction Management	Resident Engineer/Project Management	\$65,000	
C. 50 Tufts Street Subsurface Depressurization System	Installation of 22 sub-slab extraction points, 15 HP blower, and associated piping.	\$180,000	
D. Capuano School Subsurface Depressurization System	Installation of 18 sub-slab extraction points, 1.5 HP blower, and associated piping.	\$70,000	
E. 50 Tufts Street Soil Vapor Extraction System	Installation of 7 extraction points. Uses same mechanical blower as 50 Tufts Street SSDS.	\$70,000	
F. Exposure Point Elimination Measures	Installation of EPEMs in 47 residences (includes design and AULs for each residence).	\$3,375,000	
G. Site-Wide Activity and Use Limitation	Preparation of Site-wide AUL.	\$75,000	
H. Groundwater Monitoring and Reporting	Annual sampling and VOC analysis for 20 groundwater wells for 30 years.		\$322,000
I. Residential EPEM O&M and Sampling Cost	Annual air sampling (2 samples per house) and reporting, blower electrical cost, and EPEM inspection for 30 years.		\$1,639,000
J. Subsurface Depressurization System/SVE O&M Cost	Monthly inspection and electrical costs for both SSDS and SVE systems. SVE system operational for four years. SSDS operational for 30 years. Includes carbon semi-annual carbon changeouts for SVE system.		\$536,000
K. Subsurface Depressurization System Monitoring Cost	Collection of 12 air samples each from 50 Tufts Street and Capuano School Subsurface Depressurization Systems for 30 years. Collection of 8 air samples from SVE system for four years. Sampling is semi-annual for the first 5 years, then annual thereafter.		\$448,000
Subtotal Costs		\$3,960,000	\$2,945,000
Contingency on Capital Costs, 30%		\$1,035,000	
Contingency on O&M Costs, 20%		\$589,000	
Total Project Cost		\$8,529,000	

General Notes:

1. The costs provided here are estimates only and are based on our professional experience. Actual costs may be higher or lower depending on contractor quotes.
2. Quantities and design details listed in this cost basis were estimated based on a conceptual design of the remedial option at the 50 Tufts Street site. Actual quantities and design details will vary based on the final design.
3. A 5% discount factor was used.

Table O-3

RAA3 –Dual Phase Extraction, MNA, and Downgradient EPEMs

50 Tufts Street

Somerville, Massachusetts

Activity	Cost Basis	Capital Cost	O&M Cost (Present Value)
A. Preconstruction Professional Labor	Engineering Design (Excluding EPEMs) Plans, Specifications, Bids, Regulatory Submittals, Site Survey, NPDES Permit, Air Permit, and Pilot Test	\$657,000	
B. Construction Management	Resident Engineer/Project Management	\$174,000	
C. Well and Piping Network Installation	Installation of 105 dual phase extraction wells to 20 feet, Trenching (3,500 feet) and Installation of piping network for extracted groundwater and soil vapor, 11 vacuum pumps/knockouts, and two pump stations.	\$1,415,000	
D. Dual Phase Extraction Treatment System	Purchase of property and construction of a treatment system building. Installation of a 15 gpm groundwater treatment system (air stripper, catalytic oxidation system, wet scrubber, and activated carbon). Installation of a separate 1100 scfm soil vapor treatment system (catalytic oxidation system and wet scrubber).	\$1,500,000	
E. Exposure Point Elimination Measures	Installation of EPEMs in 47 residences (includes design and AULs for each residence).	\$3,375,000	
F. Site-Wide Activity and Use Limitation	Preparation of Site-wide AUL.	\$75,000	
G. DPE O&M Cost	Operation of Dual phase extraction system for 10 years. Includes labor, electrical, scrubber waste liquor disposal, and carbon changeouts.		\$5,609,000
H. DPE Monitoring Cost	Quarterly sample and analysis of 20 groundwater and 10 soil vapor/air samples and associated reporting for 10 years.		\$833,000
I. Residential EPEM O&M and Sampling Cost	Annual air sampling (2 samples per house) and reporting, blower electrical cost, and EPEM inspection. Inspection discontinued for residences located in source area after remedial activities completed.		\$1,574,000
J. Groundwater Monitoring and Reporting	Annual sampling and VOC analysis for 20 groundwater wells for 30 years.		\$322,000
K. 50 Tufts Street Subsurface Depressurization System O&M and Sampling Cost	Monthly inspection and electrical costs for SSDS system. SSDS operational for 10 years. Sample and analysis of 12 air samples. Sampling is semi-annual for the first 5 years, then annual thereafter.		\$349,000
L. Capuano School Subsurface Depressurization System O&M and Sampling Cost	Monthly inspection and electrical costs for SSDS system. SSDS operational for 30 years. Sample and analysis of 12 air samples. Sampling is semi-annual for the first 5 years, then annual thereafter.		\$368,000
Subtotal Costs		\$7,196,000	\$9,055,000
Contingency on Capital Costs, 30%		\$2,159,000	
Contingency on O&M Costs, 20%		\$1,811,000	
Total Project Cost		\$20,221,000	

Table O-3
RAA3 –DPE, MNA, and Downgradient EPEMs
50 Tufts Street
Somerville, Massachusetts

General Notes:

1. The costs provided here are estimates only and are based on our professional experience. Actual costs may be higher or lower depending on contractor quotes.
2. Quantities and design details in this cost basis were estimated based on a conceptual design of the remedial option at the 50 Tufts Street site. Actual quantities and design details will vary based on the final design.
3. A 5% discount factor was used.

Table O-4
RAA4 - Chemical Oxidation, MNA, and Downgradient EPEMs
50 Tufts Street
Somerville, Massachusetts

Activity	Cost Basis	Capital Cost	O&M Cost (Present Value)
A. Preconstruction Professional Labor	Engineering Design (Excluding EPEMs) Plans, Specifications, Bids, Regulatory Submittals, Site Survey, Bench and Pilot Tests	\$448,000	
B. Construction Management	Resident Engineer/Project Management	\$290,000	
C. Well Installation	Installation and future abandonment of 406 chemical oxidation wells. Wells installed to 20 feet below ground surface.	\$1,252,000	
D. Chemical oxidation application	Application of a total of 830,000 pounds of persulfate in two applications.	\$1,537,000	
E. Exposure Point Elimination Measures	Installation of EPEMs in 47 residences (includes design and AULs for each residence).	\$3,375,000	
F. Site-Wide Activity and Use Limitation	Preparation of Site-wide AUL.	\$75,000	
G. Chemical Oxidation Monitoring Cost	Quarterly sample and analysis of 20 groundwater and 10 soil vapor and associated reporting for 3 years.		\$294,000
H. Residential EPEM O&M and Sampling Cost	Annual air sampling (2 samples per house) and reporting, blower electrical cost, and EPEM inspection. Inspection discontinued for residences located in source area after remedial activities completed.		\$1,509,000
I. Groundwater Monitoring and Reporting	Annual sampling and VOC analysis for 20 groundwater wells for 30 years.		\$322,000
J. 50 Tufts Street Subsurface Depressurization System O&M and Sampling Cost	Monthly inspection and electrical costs for SSDS system. SSDS operational for 3 years. Semi-annual sampling and analysis of 12 air samples.		\$138,000
K. Capuano School Subsurface Depressurization System O&M and Sampling Cost	Monthly inspection and electrical costs for SSDS system. SSDS operational for 30 years. Sample and analysis of 12 air samples. Sampling is semi-annual for the first 5 years, then annual thereafter.		\$395,000
Subtotal Costs		\$6,977,000	\$2,658,000
Contingency on Capital Costs, 30%		\$2,093,000	
Contingency on O&M Costs, 20%		\$532,000	
Total Project Cost		\$12,260,000	

General Notes:

1. The costs provided here are estimates only and are based on our professional experience. Actual costs may be higher or lower depending on contractor quotes.
2. Quantities and design details listed in this cost basis were estimated based on a conceptual design of the remedial option at the 50 Tufts Street site. Actual quantities and design details will vary based on the final design.
3. A 5% discount factor was used.

Table O-5
RAA5 – Hydraulic Containment, MNA, and Downgradient EPEMs
50 Tufts Street
Somerville, Massachusetts

Activity	Cost Basis	Capital Cost	O&M Cost (Present Value)
A. Preconstruction Professional Labor	Engineering Design (Excluding EPEMs) Plans, Specifications, Bids, Regulatory Submittals, Site Survey, NPDES Permit	\$248,000	
B. Construction Management	Resident Engineer/Project Management	\$116,000	
C. Well and Piping Network Installation	Installation of 20 extraction wells to 20 feet, trenching (800 feet) installation of piping network for extracted groundwater, and two pump stations.	\$258,000	
D. Groundwater Treatment System	Purchase of property and construction of a treatment system building. Installation of a 15 gpm groundwater treatment system (air stripper, catalytic oxidation system, wet scrubber, and activated carbon).	\$1,190,000	
E. Exposure Point Elimination Measures	Installation of EPEMs in 47 residences (includes design and AULs for each residence).	\$3,375,000	
F. Site-Wide Activity and Use Limitation	Preparation of Site-wide AUL.	\$75,000	
G. Hydraulic Containment O&M Cost	Operation of hydraulic containment system for 30 years. Includes labor, electrical, scrubber waste liquor disposal, and carbon changeouts.		\$3,877,000
H. Groundwater Monitoring and Reporting	Annual sampling and VOC analysis for 20 groundwater wells for 30 years.		\$322,000
I. Residential EPEM O&M and Sampling Cost	Annual air sampling (2 samples per house) and reporting, blower electrical cost, and EPEM inspection for 30 years.		\$1,639,000
J. Subsurface Depressurization System O&M Cost	Monthly inspection of SSDS systems and electrical cost for 30 years		\$419,000
K. Subsurface Depressurization System Air Sampling Cost	Collection of 12 air samples each from 50 Tufts Street and Capuano School Subsurface Depressurization Systems for 30 years. Sampling is semi-annual for the first 5 years, then annual thereafter.		\$415,000
Subtotal Costs		\$5,262,000	\$6,672,000
Contingency on Capital Costs, 30%		\$1,579,000	
Contingency on O&M Costs, 20%		\$1,334,000	
Total Project Cost		\$14,847,000	

General Notes:

1. The costs provided here are estimates only and are based on our professional experience. Actual costs may be higher or lower depending on contractor quotes.
2. Quantities and design details listed in this cost basis were estimated based on a conceptual design of the remedial option at the 50 Tufts Street site. Actual quantities and design details will vary based on the final design.
3. A 5% discount factor was used.

